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J. F. KELLY, Editor

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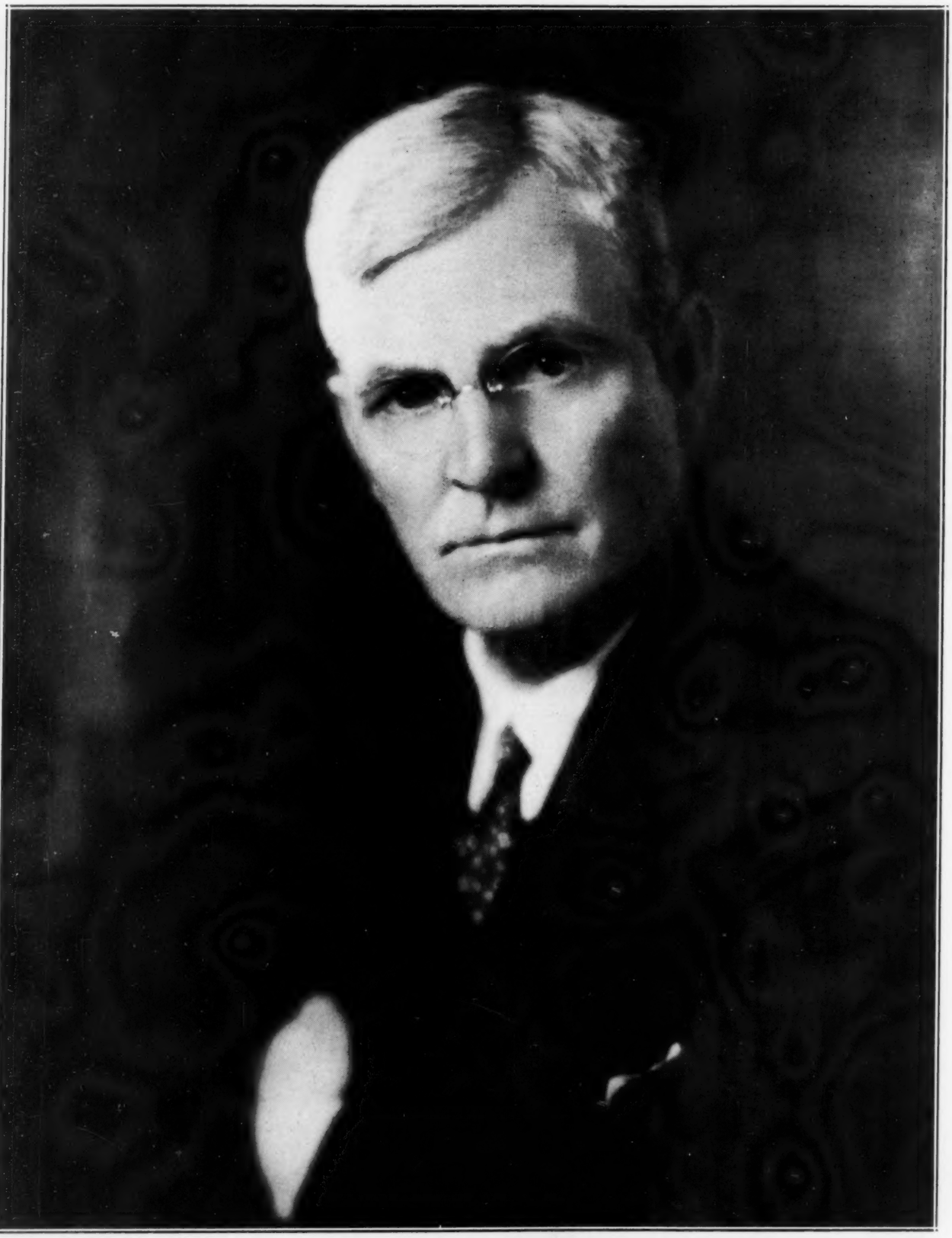


Mr. C. S. Proudfoot, General Manager, Vanadium Corp. of America, Niagara Falls, New York, who has just been elected President of the Association of Iron and Steel Electrical Engineers at their Twenty-fourth Annual Convention held at Chicago, Ill., during the week of June 25th. Mr. Proudfoot has been a member of the Association for the past twenty years.

EDITORIAL

IRON & STEEL ENGINEERS MEETING IN CHICAGO

24TH ANNUAL CONVENTION OF THE A. I. & S. E. E.*

ENGINEERS representing practically all of the steel plants in the United States attended the 24th Annual Convention of the Association of Iron & Steel Electrical Engineers held at the Stevens Hotel, Chicago, Ill., June 25 th to 28th, 1928. Papers covering electrical, mechanical, combustion and safety developments were presented by the engineers in the industry.

Mr. A. J. Standing, President of the A. I. & S. E. E., who is also Elec. Supt. of the Saucon Plant of the Bethlehem Steel Company presented a review of the activities of the Association for the past year laying special stress upon the flourishing condition of the various district sections of the A. I. & S. E. E., the financial structure, the Junior Membership and the Iron and Steel Engineer. He also reviewed the work of the various National Committees for the past year.

Mr. A. G. Place, Chairman of the Welding Committee of the Association also Electrical Engineer at the Youngstown Sheet & Tube Company presented a very able report in connection with Welding in the Iron and Steel Industry. Mr. Place emphasized the fact that the use of welding in the industry has advanced rapidly in the last six months and his report covers the following types of welding. Structural Steel Welding, Welding Replaced Castings, Welded Steel Pipe and Welded Overhead Cranes.

I. Structural Steel Welding

When we speak of the welding of structural steel we should distinguish between the use of welded structural steel in various manufacturing processes and the use of welded steel shapes for building purposes. In the first mentioned field the application of welded structural steel shapes has progressed rapidly and its progress has been proven to be economically sound. The replacement of castings for many classes of manufactured products has resulted in very tangible savings in costs, materials, and rejections and has produced a lighter and stronger product largely free from the limitations normally associated with castings.

The application of welding to steel building construction has not, as yet, advanced to the point of actual acceptance over the riveted structure in anything approaching general building operations. It has however made some noteworthy strides in this newer field and a more general use of welding in steel construction work is easy for us to visualize. To the average Fabricating Engineer this is not the case since he looks upon welding in the light of an unproven innovation which he very naturally and wisely is somewhat skeptical about accepting at its face value. He is inclined to feel that the few examples of welding successfully applied to steel construction by the large Electrical Manufacturers do not prove the case because the conditions and results may have been influenced in favor of welding. This feeling is particularly true with reference to the relative cost of welding as compared to riveting the experimental structures where the claim is made that the lowest competing bids covering the riveted structures were not used. The Fabricating Engineer fails to recognize the fact that first attempts as welded buildings are being compared on a cost basis with the old established practice on riveted buildings. It is unquestionably true that the continued application of welding will make possible additional saving due to experience and skill coupled with an improved design that will take full advantage of the possibilities welding presents in the structural field.

The general subject of structural steel welding for building purposes has been carefully taken up by the American Welding Society who have established a special committee whose function it is to make a thorough and impartial study of this newer phase of the welding development. This Committee composed of both welding experts and structural steel designing and construction engineers has laid out an exacting and most comprehensive program involving many preliminary tests of welders and their work under varying conditions to be used as a basis for the determination of the future line of tests that will best serve to bring out all the important points most necessary to properly outline and safeguard the progress of building by welding structural steel.

Various Steel Plants and Fabricating Companies have agreed to prepare, weld and test these samples in order that this Committee may be in a position to draw conclusions from composite results rather than from results obtained through any one source. The Committee's investigation will cover the following important points:

Qualification test for welders.

Procedure and specifications covering type and size of welds.

Proper and uniform nomenclature for welding literature.

Method of inspection and gauging welds.

Design features best adapted to welding.

These and many other phases of the slbject are being investigated in order to eliminate misunderstandings arising from improperly conducted or reported tests.

I do not think it is desirable at this time to mention the relatively few buildings that have been partially or completely welded or is it in the province of this report to dwell on the so-called advantages or disadvantages of structural welding. By the close of our next year there will undoubtedly be much more concrete data available from actual practice on which to base our opinions.

*Complete discussions and contributions will appear in the August number of the Iron & Steel Engineer.

General Views of Iron and Steel Exposition held in connection with the Twenty-fourth Annual Convention of the Association of Iron & Steel Electrical Engineers at the Stevens Hotel, Chicago, Ill., during the week of June 25.

II. Welding Replaced Castings

Rapid advances have been made in substituting welded steel for all kinds of castings, thereby reducing cost. The pattern inventory can be reduced, the scrapping of castings is eliminated due to discovering blow holes after partly machining, changes and improvements can be made more readily, and the total cost can be reduced.

Welded bedplates have almost entirely superseded cast bedplates in many factories.

Electric motors are now being made almost entirely of welded construction.

III. Application To Cranes

Overhead electric cranes are being experimentally built by using welded instead of riveted girders, by using welded structural end trucks, and by welded trolley side frames and cross girts.

By suitably designing the welded parts, a strong rigid construction can be obtained with much lighter weight.

With lighter weight cranes, the wheel loads can be reduced, and the saving will extend clear down through the building steel to the concrete footings, and the construction cost of a new building may be materially reduced.

IV. Welded Steel Pipe

Several large water mains from 36 inch to 60 inch diameter have recently been made by welding steel plates along two longitudinal seams. The flat plates are first shaped in a bending roll, and then welded by an automatic welding head. For large diameters, two longitudinal seam welds have been used.

The edges of the plates have been machined in a planer to prepare the edge for the weld. Materials up to ½ inch thick have been welded at the rate of 4½ inches per minute per lineal foot of completed weld.

One 22 inch line has also been electrically welded.

Conclusion

The use of welding in manufacturing processes is growing so rapidly that it is well for the members of this Association to lend their co-operation whenever possible to advance the fund of knowledge available on the use of welding.

Mr. Walter Burr, Chairman of the Electric Development Committee who is also Electrical Supt., at the Lukens Steel Company in Coatesville commented as follows: In going over the developments of the past year one cannot help but be impressed with the following facts: on most of the modern continuous mills motors are being installed on each roll stand.

DC motors are being used to a greater extent than ever before on reversing operations, where wide ranges of speed are required and where close regulation is necessary.

On mills where continuous running motors are required the synchronous motor is being used very extensively, due to the fact that motors of the present design develop considerable starting torque and starting equipment is reduced to a minimum.

The outstanding factor in crane design for this year would seem to be the increased use of anti-friction bearings and worm drives.

In control design there has been additional development of and a growing demand for definite time limit acceleration on controllers for use with auxiliary mill motors.

In the auxiliary motor group there has been developed recently a new type of motor which can be used for auxiliary drives which has all the good characteristics of enclosed type motors. The increased use of armorclad cable and also truck type switchboards is in keeping with present day safety movements and the advantages gained fully warrant the additional investment.

Mr. A. C. Cummins, Chairman of the Standardization Committee who is also Electrical Superintendent of the Duquesne Works of the Carnegie Steel Company reviewed the work for the past year and advised that the specifications as submitted in the June issue of the Iron and Steel Engineer covering the standardized mill type motor was final. Motors are now being built under these specifications and will continue to be built without further changes. Mr. Cummins also reviewed the present status of the Standardized General Purpose Motor being sponsored by National Engineering Societies.

Mr. George H. Schaeffer, Chairman of the Electric Heat Committee who is the Electrical Engineer at the Carpenter Steel Company, Reading, Pa., presented a very able report which appeared in the June issue of the Iron and Steel Engineer. Mr. Schaeffer requested the membership to make use of the Electric Heat Committee during the next year and advised that if they have any problems they would like acted upon the Committee would be glad to co-operate with them in every particular. The National Electric Light Association presented a moving picture story covering the various phases of electric heat which was well received.

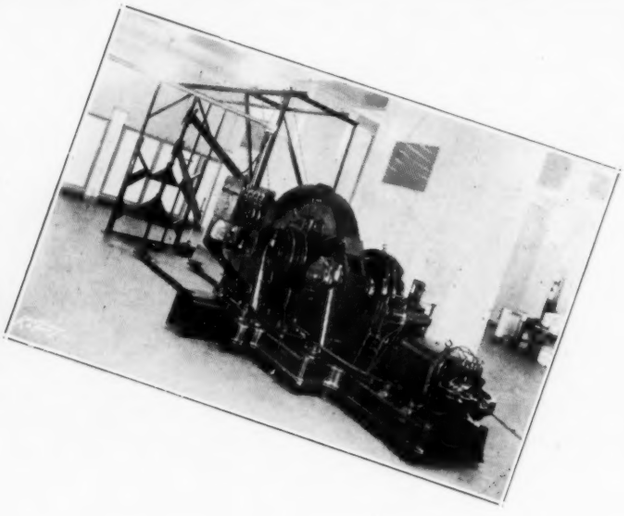
Mr. L. H. Burnett, Vice President of the Carnegie Steel Company was the honor guest at the Monday luncheon at which time he presented one of the most able addresses that the A. I. & S. E. E. has been privileged to enjoy. One of the salient points that Mr. Burnett brought out is his address was that all great movements must be judged by the results that they have attained and that being the case the safety movement could certainly speak for itself. It was built on the solid and firm foundation of saving lives.

He also commented on the Association's Junior Membership and outlined the advantages to be gained if the men down along the line affiliated themselves with the A. I. & S. E. E.

Mr. Homer Niesc, President of the National Safety Council made a splendid address covering the work of the National Safety Council.

Mr. Charles B. Scott of the Middle West Utilities Company read Mr. Eugene Vinet's paper which appeared in the June issue of the Iron and Steel Engineer. Mr. Scott brought out the point not covered by Mr. Vinet's paper in connection with fire insurance policies now being issued by fire insurance companies which contains the electrical apparatus clause.

Mr. J. C. Dobelbower of the Crocker Wheeler Elec. Mfg. Co., Ampere, New Jersey, presented a very interesting paper which also appeared in the June issue of the Iron and Steel Engineer entitled



General Views of Iron and Steel Exposition held in connection with the Twenty-fourth Annual Convention of the Association of Iron & Steel Electrical Engineers at the Stevens Hotel, Chicago, Ill., during the week of June 25.

"Present Practices in Connection with Motor Driven Rollers."

Mr. W. S. Hall, Electrical Engineer, Illinois Steel Company, South Chicago, Ill., expressed the opinion that the individual drive on run out rollers was satisfactory and very little trouble should be experienced.

Mr. F. W. Cramer, Assistant Electrical Engineer, Bethlehem Steel Company, Johnstown, Pa., discussed group drive versus individual drives. On all of their new mills installed at Johnstown run out rollers are used. He also brought up the point that care should be exercised on your first run out rollers to protect them from the scale of the mill. In three years experience with about two hundred of these motors, very little trouble has been experienced.

Mr. L. A. Umansky of the General Electric Company, Schenectady, N. Y., brought up the subject of the use of the anti-friction bearings on run out rollers. In his opinion he questioned very much whether any type other than anti-friction bearings should be used for this class of service.

He also brought up the question of rating of the motors. He felt that the motors should be rated on the torque basis instead of saying that they have a rating of any certain HP. .

Mr. Harold of the Reliance Electric & Engineering Company, Cleveland, Ohio, discussed Mr. Dobelbower's paper. In his discussion he brought up the Schloemann Motor Rollers that had been built in this country so far. They have all been rated on the torque basis.

Mr. F. B. Crosby, Electrical Engineer of the Morgan Construction Company, described how his company had started in 1918 to install small motors on individual rolls in some of their mills and applications on cooling beds. Up until that time they had been using the cone roller application driving the roll with cables and the upkeep of these was very high. Today Morgan Construction have something over six hundred individual motor driven rollers in operation and the results have been such as to justify a continuance of these direct connected motors.

Mr. A. L. Foell, Chief Engineer of the Donner Steel Company, Buffalo, N. Y., described their installations most of which are driven by cables. The life of the cables is varied between two and thirteen weeks. Mr. Foell explained that the handicap in their consideration of motor rollers had been due to the fact that on their 14-inch mill they must positively stop and start after each bar on certain occasions. It seemed to Mr. Foell that this was an application that could not be readily handled with the motor roller.

Mr. R. M. Hussey, Electrical Engineer, Jones & Laughlin Steel Corporation, Aliquippa, Pa., discussed reversing service on motor rollers.

Mr. A. F. Kenyon, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa., advised that they were making applications to individual motors which stop and start frequently and a careful analysis of the applications indicated a somewhat different method of control than that which had been used heretofore. Mr. Kenyon's opinion was that heretofore on reversing applications you merely plugged the motors and reversed the one phase of the motor and in that way stopped them and started them in the opposite direction.

Following the luncheon on Tuesday, June 26th, 1928, Mr. John B. Taylor of the General Electric Company at Schenectady, N. Y., discussed some of the relations between sound and light. At that time he made use of special apparatus set up to give an impressive demonstration in which music was carried from one side of the room to another in a beam of light.

Mr. J. H. McElhinney, Assistant General Superintendent of the Lukens Steel Company at Coatesville, Pa., presided at the Wednesday technical sessions.

Mr. L. B. McMillan of the Johns-Manville Corporation, New York, N. Y., presented a paper entitled "Insulation of Open Hearth Regenerators."

Mr. Walter Kennedy of the Sil-O-Cel Company, discussed this paper at some length. He advised that it is now general practice to insulate around the checker chambers, flues and boilers. Also, that quite a number of furnaces had been insulated around the slag pockets up to the charging floor level, also around the stock bases to protect the concrete from calcimining and cracking.

With the exception of one small acid furnace all the open hearth furnaces and a number of furnaces built in the United States in 1927 were insulated.

Mr. Kennedy claimed by the usual method of application insulation reduced the loss from 60 to 75%. The heat retained being used for work in the furnaces.

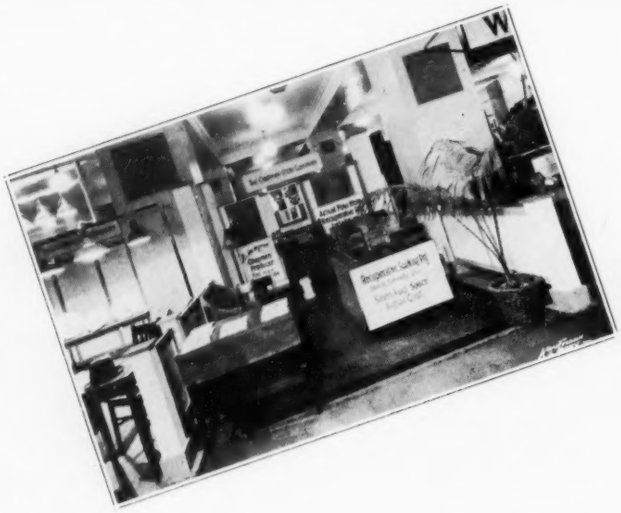
In one of the open hearth plants in the Pittsburgh District some of the revamped old open hearth furnaces using insulation, melted steel on an average of fifty minutes faster per heat than the uninsulated furnaces.

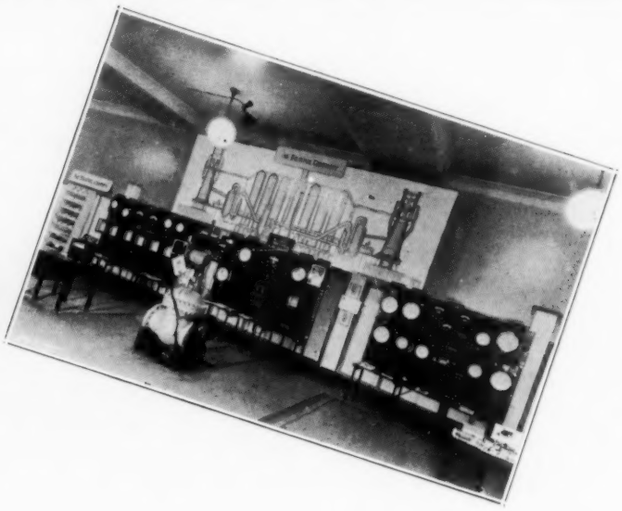
Mr. Ramsey of the Wisconsin Steel Company, discussed his experiences with insulation. The greatest change that he had noticed from the use of insulation was the effect on the infiltration of air. He advised that they were prepared to insulate one of their open hearth furnaces completely. In addition to the insulation they expect to encase the chamber in steel.

Mr. A. L. Foell of the Donner Steel Company, Buffalo, N. Y., felt that insulation has its advantages. On an old installation, however, or on an existing open hearth furnace the problem of insulating the checker chambers effectively and economically is not quite so easy or simple. He brought up the point of preventing or making it impossible to get the same amount of air infiltration through the checker walls, for unless the insulation can be properly tied into the existing brick walls it will be somewhat difficult to prevent the air infiltration, which all of us consider an important and vital consideration.

Mr. Foell's discussion was very interesting and will appear complete in an early issue of the Iron and Steel Engineer.

Mr. A. J. Standing, Electrical Superintendent of the Saucon Plant of the Bethlehem Steel Company, discussed Mr. McMillan's paper from the waste heat boiler point of view.





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Mr. A. G. Witting, Assistant Chief Engineer, Illinois Steel Company at Gary, Ind., advised that practically everybody agreed on the principle of insulation. Also, that any one that has tried it has no doubt secured results that are both practical and satisfactory. He questioned however the ability to compute in dollars and cents on any fuel saving what the savings really are.

Mr. Arthur Steed of the American Rolling Mill Company, questioned whether it was proper to credit all of the savings around the open hearth to insulation. Mr. Steed felt that the increased temperature of the air and gas gave a better furnace condition but wondered if the stack losses would not be slightly higher.

Mr. W. R. Chambers of the Laclede Steel Company, advised that they had applied insulation to furnaces that were in operation and to new furnaces. Some of the furnaces that were insulated were in operation just using the ordinary grade of insulating brick. Where the outside walls and checkers have been uneven, as they often are, they have just put a plate across and filled them with powdered insulation. He also advised that the insulation saving is so involved with other savings that it is very hard to find.

Mr. McMillan answered Mr. Steed's question that it was very likely that the stack temperatures would be increased but the amount of air due to decreased infiltration would be less with the result that there would be no increase, possibly a decrease in actual stack losses.

Mr. E. R. Fish, Vice President of the Heine Boiler Company, presented the paper "Boiler Pressures above 500 Pounds." Mr. Fish in his paper brought out the thought that the engineers in the steel industry had approached the problem of high pressures very slowly. Also, that the high pressure work and plan originated with the central station. They have been the pioneers in this type of development.

Mr. Fish felt that the high pressure development was unquestionably branching out into the industries and that it was just a question of time until the industry would be using these high pressures. When the time comes, distributing this high pressure steam over a large area with long lines of piping, it will be more or less out of the question, but the establishment of central stations in the industry and the adoption of the electric drive and all those things will make it possible to apply these high pressures provided you utilize your high pressures in a restricted area and distribute your energy electrically.

Mr. Shadgen of the Smoot Engineering Company, discussed feed water problems of high pressure boilers.

Mr. Morgan B. Smith, Engineer of Purchases, General Motors Corporation, contributed one of the most interesting papers that has been presented before the A. I. & S. E. E. for some time entitled "Factors Governing the Purchase of Coal." Mr. Smith's paper appeared in the June issue of the Iron and Steel Engineer. The discussion of his paper will appear in an early issue.

Mr. R. M. Walker, Engineer of the Bristol Company at Waterbury, Conn., presented a very valuable paper entitled "Recording and Control Instruments in the Iron and Steel Industry." In Mr. Walker's paper is a compilation and tabulation of the application of instruments in the various departments in the Iron and Steel Industry.

This is a very valuable reference for the engineers in the industry.

Mr. C. L. Saunders of the Brown Instrument Company, discussed Mr. Walker's paper and brought out the fact that purchasing and installing instruments is one operation and that maintenance is another. Maintenance may be described as your insurance against disuse or loss of expected advantages from the installation. The amount and quality of the maintenance is a direct function of the type of instrument and the character of the installation. Mr. Saunder's felt that there should be instrument departments organized in plants where the instruments could be properly serviced.

Mr. W. J. Harper of the Donner Steel Company, presented a very interesting discussion listing the advantages of the recording meter as a saving of fuel. Today blast furnace gas is one of the most efficient fuels we have in the industry. If we put recording instruments on our blast furnace stoves and take stoves off on stack temperatures instead of the old rule of two hours on gas and one hour on air, we will have at least five per cent more fuel to put under the boilers for the generation of power or for the operation of gas blowing engines.

Mr. Harper also presented a discussion in connection with the use of a recording meter in the operation of an oil electric locomotive.

Mr. W. B. Skinkle, Engineer, Pittsburgh District Power Committee, Subsidiary Companies of the United States Steel Corporation, presented a paper "Discussion of Elements Entering Into the Cost of Producing Power." This paper is one of the most complete of its kind that has ever appeared in print and no doubt will be used as a basis in the future for the compilation of costs. Mr. Skinkle's paper appeared in the June issue of the Iron and Steel Engineer.

Anti-friction bearings for Motors, Auxiliaries and Roll Necks occupied all of Thursday morning at the Convention. A very valuable discussion prepared by Mr. D. M. Petty of the Bethlehem Steel Company covering Anti-Friction Bearings for Roll Necks was presented and will appear in the August issue of the Iron and Steel Engineer.

Anti-friction bearings is discussed by Mr. Poto of the Alliance Machine Company, Mr. Fred Waldorf of the Timken Roller Bearing Company, Mr. F. W. Cramer of the Bethlehem Steel Company, Mr. E. C. Gainsborg of the SKF Industries, Inc., Mr. J. S. Murray of the Follansbee Brothers Company, Mr. J. H. VanCampen of the E. W. Bliss Company, Mr. W. L. Iliff of the Hyatt Company, Mr. D. E. Batesole of the Norma Hoffmann Bearing Corporation, Mr. R. M. Hussey of the Jones & Laughlin Steel Company, Mr. L. A. Umansky of the General Electric Company, Mr. A. C. Cummins of the Carnegie Steel Company.

The Informal Reception on Monday evening under the auspices of the Chicago District Section and headed by Mr. C. J. Smith of the Illinois Steel Com-

Mr. L. H. Burnett, Vice President, Carnegie Steel Co., Pittsburgh, Pa., whose address on "Education and Safety in the Iron and Steel Industry" at the Twenty-fourth Annual Convention of the Association of Iron and Steel Electrical Engineers was easily the leading feature of the Convention.

pany, was one of the most successful affairs of its kind in the history of the A. I. & S. E. E.

The Formal Reception on Thursday evening headed by Mr. J. J. Booth of the Gary Tube Company, was also one of the features of the week and the program offered the members of the Association made for them an entertaining and enjoyable evening.

The registration was handled by Mr. James L. Mills of the Illinois Steel Company. A complete record was obtained of all those members and guests who attended the Convention. Mr. Mills and his committee were congratulated on the thoroughness of their work.

Mr. H. E. Davis, Electrical Superintendent, Interstate Iron & Steel Company, was Chairman of all of the Convention activities and the A. I. & S. E. E. are indeed very grateful for one of the most successful Conventions in its history.

As to the Iron and Steel Exposition, we believe it was among the most successful ever held and speaks well for the City of Chicago as a Convention City.

Practically every exhibitor was visited during the show and asked for his views. In practically every case they all expressed their satisfaction with the general arrangements of the exposition and seemed more than willing to participate in any future affairs conducted by our Association.

Not only was the display in itself truly representative of the Iron and Steel Industry but the engineers in attendance from the various steel plants felt highly honored for the preparations and efforts put forth in bringing to the exposition the equipment and apparatus in which they were directly interested and which showed the latest practices being followed in the modern and up to date plants throughout the country.

The exhibitors should be and are here congratulated for the splendid manner in which they arranged their exhibits and it is the hope of the Society that all the manufacturers who participated were directly benefited by their participation in the 1928 Iron and Steel Exposition.

The manufacturers who were represented at the Exposition are:

Alliance Machine Co.
Allis-Chalmers Mfg. Co.
Appleton Electric Company
Aluminum Co. of America
Bristol Company
Baker-Raulang Company
Bussmann Mfg. Co.
Bartlett Hayward Company
Benjamin Electric Mfg. Co.
Bulldog Electric Products Co.
Chapman-Stein Co.
Crocker-Wheeler Elec. Mfg. Co.
Cutler-Hammer Mfg. Co.
Clark Controller Co.
Colts Patent Fire Arms Mfg. Co.
Chicago Fuse Elec. & Mfg. Co.
Crouse-Hinds Company
Philip Carey Company
Cutter Elec. & Mfg. Co.
John C. Dolph Company
M. H. Detrick Company
Economy Fuse & Mfg. Co.
Electric Controller & Mfg. Co.
Electrical Journal
Edison Storage Battery Co.
Electric Storage Battery Co.
Electrical Engineers Equipment Co.
Elliott Company
Erie Malleable Iron Co.
Electric Service Supplies Co.
Electric Machinery Mfg. Co.
Freyn Engineering Co.
Fairbanks Morse Company
D. B. Flower Mfg. Co.
G. & W. Electric Specialty Co.
Green Equipment Corp.
General Electric Co.
Hagan Corporation
Hyatt Roller Bearing Co.
Hodson Corporation
Holophane Company
Ideal Commutator Dresser Co.
Industrial Engineering
Iron & Steel Engineer
ITE Circuit Breaker Co.
Ivanhoe Division of Miller Co.
Johns-Manville Corp.
W. J. Jeandron
Keystone Lubricating Co.
Lincoln Electric Co.
Lapp Insulator Company
Le Carbone Brush Company
Metal & Thermit Corp.
Monitor Controller Co.
Morgan Engineering Co.
Manning Maxwell & Moore, Inc.
Martindale Electric Co.
Henry N. Muller Co.
Norma-Hoffmann Bearings Corp.
National Carbon Company
National Air Filter Co.
Nichols Lintern Co.
R. D. Nuttall Company
New Departure Mfg. Co.
National Lamp Works of G. E. Co.
Otis Elevator Company
Ohio Electric & Controller Co.
Okonite Company
Pittsburgh Elec. & Machine Works
B. F. Perkins & Sons
Pyle-National Company
Reliance Electric & Engr. Co.
Robinson Ventilating Co.
Rockbestos Products Corp.
Rollway Bearings Corp.
Rowan Controller Co.
Roller-Smith Co.
Republic Flow Meters Co.
Reed Air Filter Co.
Schweitzer & Conrad
SKF Industries, Inc.
Square D Company
Standard Underground Cable Co.
Steel Publications, Inc.
Shaw Crane Putnam Machine Co.
Timken Roller Bearing Co.
Tool Steel Gear & Pinion Co.
Thompson Electric Co.
Harold E. Trent
Trumbull Elec. Mfg. Co.
United States Graphite Co.
V. V. Fittings Co.
Edwin L. Wiegand Co.
Westinghouse E. & M. Co.
Wheeler Reflector Company

The following is the result of the ballotting for the election of officers for the ensuing year:
DIRECTORS 1928-1929

C. S. PROUDFOOT, President—General Manager, Vanadium Corp. of America, Niagara Falls, N. Y.

F. W. CRAMER, 1st Vice Pres.—Asst. Elec. Supt., Bethlehem Steel Company, Johnstown, Pa.

A. G. PLACE, 2nd Vice Pres.—Elec. Engr., Youngstown Sheet & Tube Company, Youngstown, Ohio.

JAMES FARRINGTON, Treasurer—Elec. Supt., Wheeling Steel Corporation, Steubenville, Ohio.

A. A. STEWART, Secretary—Elec. Engr., Pittsburgh Steel Company, Monessen, Pa.

KARL L. LANDGREBE, Director at Large—General Supt., Tennessee Coal, Iron & R. R. Co., Ensley, Ala.

M. J. CONWAY, Engineering Section Director—Fuel Engineer, Lukens Steel Company, Coatesville, Pa.

E. F. BLANK, Engineering Section Director—Chief Safety Engineer, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

I. N. TULL, Director—Elec. Engr., Corrigan McKinney Steel Company, Cleveland, Ohio.

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*Education and Safety in the Iron and Steel Industry**

By L. H. BURNETT†

MR. Chairman, Members of the Association of Iron and Steel Electrical Engineers: It is always a privilege and a pleasure to me to speak to members of your organization, knowing as I do the important part that you have played in safety.

In my work I come in touch with a great many activities, but of all these, safety has given me more real happiness and satisfaction than any other particular thing connected with my daily tasks.

Your organization is really a pioneer in organized safety work. It was largely through your activities that the National Safety Council, as we know it today, was formed, and your child has done remarkably well. I do not know of any organization in the world that has done more or deserves better from the people at large than the National Safety Council. As you know, it is a clearing house of all the information in safety matters. It provides literature to you men and to others who employ men in hazardous occupations. Its influence today is worldwide.

At the time you were instrumental in organizing that great force, we all thought that nothing was necessary in safety except perhaps mechanical safeguards. We thought if we could cover every gear wheel, countersink every set screw, do away with the dangerous mechanical contrivances that we would practically prevent all accidents. Today we have learned better.

They say that every great movement must be judged by the results which it attains. If it lacks sincerity or is not built upon a firm foundation of public good and welfare, it cannot endure, but will fall of its own weight. If that is true, safety certainly can speak for itself. It is built on the solid and firm foundation of saving lives and preventing pain and suffering. It stands out, today, as the one greatest achievement of modern industry.

No questions were raised at this time of any economic advantages of safety work. We knew nothing then but the humanitarian side of it. The economic side came later. But when we judge from results, we can certainly agree that the organized safety movement has been an unmixed blessing to all of us. While we have been obtaining wonderful results in safety, you men, and men like yourselves, have been making marvelous records in efficiency, increased tonnage, better product and decreased man power. An efficient plant today must have modern machinery, usually electrically driven, must be well lighted, must be clean, must have adequate working spaces, and above all else, must have an intelligent working force.

The same attributes are necessary for safety. It is indeed a most fortunate thing that safety and efficiency today go hand in hand, and the most efficient plant is the safest plant.

Four years ago, by vote of your organization, in the City of Philadelphia, you again entered actively into the safety campaign to do your share towards the prevention of accidents due to electrical hazards. At that time we had all learned that something more than mere mechanical safeguarding was necessary. We had learned that if we were to have a safe plant it would be necessary to educate our working forces, at least to give them some knowledge of the dangers that they faced in their daily tasks.

That you have done a good job in your line is shown by the fact that there has been a steady and most perceptible decline in accidents due to electrical hazards and this has been accomplished in face of the fact that the use and application of electricity and electric power, in steel plants, has grown with leaps and bounds. Electricity has not only made for safer places to work, but it has done a great deal more for the men in our plants. It has been largely instrumental in doing away with much of the hard and grueling labor which our men were formerly required to do. It has given us much better light and has even added to the welfare of our men by providing them with electrically-cooled drinking water, which is no small item.

As to the reduction of accidents, in the period of the last eleven years, in one company employing about 45,000 men, 3% of the lost time accidents have been due to electrical hazards, while 10% of the working force were in the electrical department. This record has been due to the better and safer installation, but particularly, in my opinion, to the increase in the education and preparation of our men.

Much, indeed, has been accomplished, but we would fool ourselves if we did not know and believe that much still remained to be done, and if you will parden me, it is not a pleasant thing to talk about, but illustrating my point, I would like to cite two fatal accidents occurring in two different plants within the last six months, both fatalities happening to painters.

In one case, they were painting poles carrying high tension lines. The man in charge of the work, the electrical man, told the man at the powerhouse to cut off the power to all lines except one. These circuits were known by numbers, and unfortunately, in giving the direction he gave the wrong number. The painter ascended the pole and started to work, thinking the juice was off on all except one line. As I stated, he thought it was another line. He touched the line that he thought was dead and was killed.

In the other case the painter was painting a roof. His foreman warned him that the high tension lines were near, and unfortunately, they were only two feet above the roof. This man had on his safety belt, but in spite of the warning he touched the wire and was killed.

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*Presented at Twenty-fourth Annual Convention, A. I. & S. E. E., June 25-28, 1928.

†Vice President, Carnegie Steel Co., Pittsburgh, Pa.

Now, we might say that in the first case it was an unfortunate mistake and let it go at that. We might say in the second case that the man ought to have known better and let it go at that. But as a matter of fact, I talked to the managers of both those plants, and they both told me that it would not have interfered with the operation of those plants, that it would not have been any great inconvenience if the juice had been turned off entirely from both those lines. And after all, gentlemen, that is the real cause of both of those accidents, and it rests in this fact, that there is still some lack of co-operation between the various departments in some of our large plants, and also that we are still bound round by that old idea that we cannot depart from the regular humdrum day in and day out operation of a plant.

So I say to you, gentlemen, that if you can add your bit to overcoming that old-fashioned idea that we must not depart from ordinary operation, no matter what the cause, you will be doing a wonderful thing for yourselves and for your men and for your employers. After all, when it is all said and done, in the last analysis, the question as to whether or not you are going to have a safe plant depends upon the general intelligence of the men in your force, and that brings me to the thing that I want to speak to you about especially today, and it is another child of your own.

I have been told and I have read that it is the intention of this great organization to establish a Junior Membership Section. In my opinion, there is nothing of greater importance and of greater benefit to your industry than the education of the man on the job, and your membership is best fitted to carry on that work by reason of your position, by reason of your experience—you know exactly what the man on the job ought to have and how he ought to get it. You will give the men in your departments the necessary information to carry on their daily work intelligently.

But in addition to that, such a course is bound to stimulate his desire for more knowledge, broaden his entire horizon and fit him for advancement. It has been said that a little knowledge is a dangerous thing, and that is true, within certain limitations, the same as all those old sayings have a modicum of truth about them. But it is also true that knowledge is power. A fair working knowledge of fundamentals, of primary facts with reference to electrical matters will be a blessing to the rank and file of electrical workers and to you as their superiors. Let us remember that an individual can never stand still. He is going forward or else he is losing ground. Each day should find every one of us getting knowledge, getting experience, getting more skill—growing. Your Junior Membership Department will help the man on the job to grow. In opening the way for him you are rendering a real service to yourselves, your men and to your industry, and I predict without hesitation that within a very short time your Junior Membership Department will become a most important section of your work in this great organization, and one in which you will find the greatest pride and satisfaction. I thank you.

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*Effect of Transient Phenomena on the Design and Selection of Alternating Current Equipment**

By E. G. MERRICK†

BEFORE transient electrical phenomena were as well understood as they are today, it was customary to attribute many of their effects to so-called "resonance." This term was very elastic and covered a wide field of unexplainable, abnormal conditions.

At that time the engineers responsible for the design and application of apparatus were faced with certain difficult problems; equipment adequate in every way to meet normal operating requirements was frequently damaged during momentary disturbances; other apparatus, which had previously withstood successfully both normal and transient conditions, would fail after certain changes had been made in the electrical system.

As long as the nature and magnitude of these transients were undetermined, it was impossible to establish any standards relative to design and application which would give suitable factors of safety. Many of these transient phenomena are now, however, fairly well defined and it is possible to predict with considerable accuracy the duty which may be imposed on apparatus under varying conditions.

The ability of apparatus to withstand various transient duties has also been determined by extensive shop and field tests, so that we are now in a position to design and apply electrical equipment with a certain degree of confidence in its ability to meet abnormal, as well as normal, conditions of operation.

The individual characteristics of certain classes of apparatus determine the magnitude of the transients to which they may be subjected; in other cases, the magnitude is determined by a combination of the characteristics of the various apparatus comprising the electrical system. The first case presents a problem of design only, the latter case one of application. The purchaser is, however, concerned with both problems, as he must be able to specify either the general or specific duty for which each piece of equipment shall be suitable.

*Presented before Philadelphia Section, A. I. & S. E. E., January 7, 1928.

†Engineer, Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

The transients most generally encountered are:
(a) Transients due to short circuits and "grounds".
(b) Transients due to switching.
(c) Transients due to lightning.

The selection of apparatus to meet the conditions of cases (b) and (c) is based largely on experience and the data which has been acquired applies rather to plants in general than to particular installations.

The selection in case (a) is subject to more accurate mathematical analysis and depends more definitely on individual plant conditions; as the scope of this paper must necessarily be limited, it will deal mainly with this class of transients.

GENERATORS

If a synchronous machine is suddenly short-circuited at its terminals, when operating at normal voltage, an abnormal condition results, as shown in Fig. 1. The armature current rises almost instantly to a value limited mainly by the transient reactance of the stator and rotor and gradually dies down to a sustained value determined by the synchronous impedance. The characteristic variable displacement

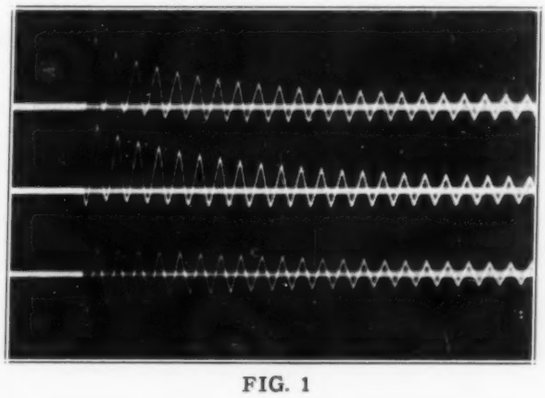

FIG. 1

of the current in the different phases with respect to the zero axis, shown by the oscillogram, depends upon the period of the voltage wave at which the short circuit occurs.

The transient current in the armature windings not only causes abnormal heating of the copper, but produces forces of repulsion or attraction between coils, which are far in excess of those due to the normal current. These stresses vary as the square of the current and, at the instant of short circuit, may be several hundred times their normal values.

Fig. 2 indicates the manner in which coils may be distorted if insufficiently braced. Such distortion of the windings may damage the insulation and cause internal failures between turns or phases or failures to ground.

Experience gained from the results of actual short circuits has led to various methods of bracing armature coils so as to prevent deformation.

The transient short circuit current in the armature produces in turn a transient alternating current and voltage in the field winding, as shown in Fig. 3. This induced field potential may be considerably in excess of the normal direct current voltage and sufficient insulation must be provided to insure against failure to ground.

During the period of short circuit, abnormal stresses are produced in the shaft, rotor arms, coupling bolts, pole fastenings, foundation bolts, etc., and require liberal design factors to prevent damage to these parts.

The sustained short circuit current of an alternator, corresponding to the excitation for full load and 0.8 power-factor, usually reaches a value two or three times the normal rated current. If this

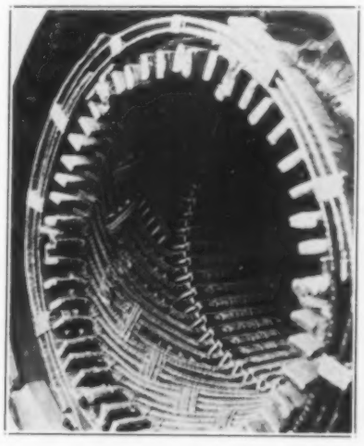

FIG. 2

condition is maintained, it is obvious that the armature winding will be subjected to abnormal heating. Automatic protection is, therefore, required for disconnecting faulty feeders from the bus before the coil insulation is endangered.

In case of internal failure in the generator windings or in the leads between the generator and bus, it is desirable to disconnect the machine from the bus and remove the excitation as quickly as possible, so as to minimize the burning of iron and insulation; this is usually effected by differential relays which are operative only in the event of faults of this nature. The differential relay trips

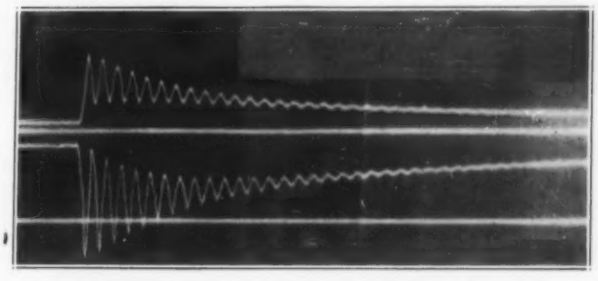

FIG. 3

both the main and field switches thus "killing" the machine completely.

Generators should be designed to withstand momentary short circuit at their terminals, when operating at rated voltage, current and power-factor. This is one of the cases, previously mentioned, where the magnitude of the transient depends upon the characteristics of the individual apparatus and hence presents a problem of design only.

POWER TRANSFORMERS

If normal voltage is applied to one winding of a transformer and the other winding is short-circuited, the resulting current will produce abnormal stresses in individual coils and abnormal forces of repulsion or attraction between adjacent coils. These forces may deform the windings or break clamps, yokes and bolts. Fig. 4 illustrates clearly the possible results mentioned. In this particular case, the transformer was intentionally subjected to abnormal

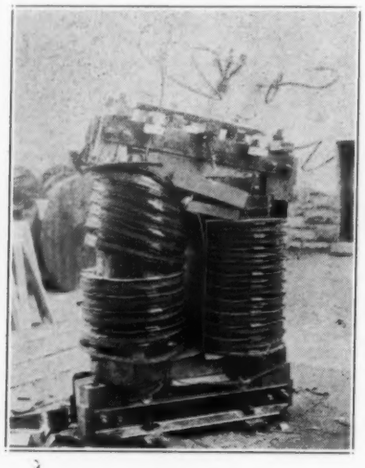

FIG. 4

short circuit conditions until failure occurred, in order to obtain desired design data. The resulting forces had an initial value of 14 times and a sustained value of six times the maximum possible short circuit stresses at rated voltage. The illustration indicates, however, the manner in which designs of weaker construction may fail under less severe conditions.

As in the case of generators, transformers must be relieved as quickly as possible from carrying abnormal currents and this requires suitable relay protection for the system. Differential protection for the units themselves is also often desirable, in order to minimize the damage due to internal failures.

Transformers should be designed to withstand momentary short circuits at their secondary terminals with normal primary voltage maintained; in this case also the duty depends upon the individual design.

OIL CIRCUIT BREAKERS

The effect of transient phenomena on the design and selection of circuit breakers is of particular interest to the individual plant operator, as reliability of service depends to so great a degree on having switching equipment adequate for the duty in each installation.

While breakers vary in size and design, according to their normal ratings, these variations are affected to a much greater extent by transient duties. The initial rush of current, due to a short circuit, produces abnormal mechanical strains and heating in both automatic and non-automatic switches. If automatic, the breaker must furthermore be capable of interrupting successfully any value of current within its rating.

The Interrupting Rating, Operating Duty and Interrupting Performance of oil circuit breakers are defined in the Standardization Rules of the A. I. E. E.

The effects of short circuit transients on an experimental breaker, tested to destruction, are shown in Fig. 5. This gives an idea of the enormous stresses to which switches may be subjected.

In selecting a breaker, the rupturing and short-time current carrying capacities, given by the manu-

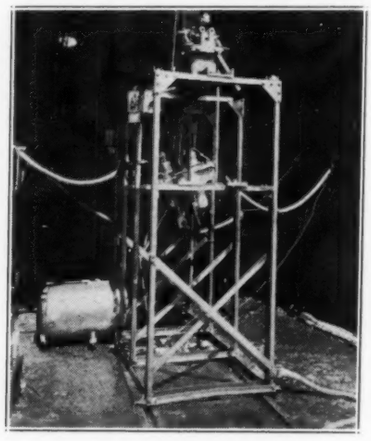

FIG. 5

facturer, should provide suitable margins above the corresponding duties which have been predetermined for the particular application.

DISCONNECTING SWITCHES

Where knife-blade switches are mounted horizontally, with blades opening downward, it is customary to provide safety catches which will hold the switch securely in the closed position; otherwise, if subjected to vibration, the blades may open accidentally due to insufficient pressure of the clips.

Even when installed in such a position that gravity has no tendency to open the blade, positive locking is often necessary to meet severe short circuit conditions. The tendency of a current loop is to assume a circular form; this action in the rectangular-shaped switch circuit tends to force the blade out of the contacts.

Table I gives the current limitations set by one manufacturer, beyond which safety catches should be used.

TABLE I

USE OF SAFETY CATCHES ON DISCONNECTING SWITCHES FOR INDOOR SERVICE

Rated Capacity of Switch In Amperes	Maximum Current Which Switches May Carry Without Safety Catches
300	10000
400	11500
600	15000
800	16500
1200	20000
1600	23000
2000	26500
3000	32000
4000	37500
5000	42000
6000	46000
8000	53000
10000	59000

The forces in each individual switch loop, combined with the forces of attraction or repulsion between adjacent loops, produce bending moments in the porcelain supports which must, therefore, be made sufficiently rigid.

CURRENT TRANSFORMERS

In many cases, the application of current transformers has been based solely on the normal operating conditions of the circuits in which the transformers were to be installed—the selection being governed by the primary voltage and load current, the proper current ratio and the volt-ampere burden of the secondary. The fallacy in this method of selection lies in choosing the transformer with reference only to the individual circuit in which it is to be installed and not with reference to the system of which the circuit is a part.

If several feeders of different ampere capacities are connected to a common bus, the same maximum transient currents may occur in each one. The ratio of this current to the normal ampere capacity of each feeder is, therefore, a variable quantity.

Each design of current transformer is limited in the amount of current which it can safely carry, both by mechanical and thermal considerations and the selection must be governed accordingly. For the types of construction in common use, A. I. E. E. Standards recommend that the transformer shall withstand a current of 40 times normal for one second; this is assumed to be a safe limit within which the compounds used will not vaporize and will, therefore, prevent porosity of the insulation.

TABLE II

THERMAL LIMITS OF TYPICAL CURRENT TRANSFORMERS
ONE SECOND RATINGS IN AMPERES

Rated Primary Amp.	4500 V.				7500 V		15,000 V.		
	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7	Type 8	Type 9
20	1375	10000		1700			2000	10000	
30	2185	10000		2800			3000	10000	
40	2870	17500		3400			4000	10000	
50	3660	30000		4500	17500		5100	17500	
60	4145	30000		5100	17500		6300	17500	
80	5730	30000		7500	17500		8250	17500	
100	7370	40000		9400	17500		10500	30000	
150	10880	40000		14000	25000		17700	30000	
200	12250	40000		18000	25000		20500	30000	
250	19200	40000		21800			23700		
300	20900	40000		27000			32250		
400	29400	65000		33000			40250		
500	33000	65000		37000			46000		
600	55000	65000		55000			57000		
800	67500	65000		73000			76000		
1000			55000			55000			55000
1200			74000			74000			74000
1500			74000			74000			74000
2000			149000			149000			149000
3000			198000			198000			198000

½ Second Rating = 1.41 × One Second Rating ¼ Second Rating = 2.00 × One Second Rating

The values of transient current which any particular transformer will withstand for varying intervals of time, without mechanical or thermal damage, are usually supplied by the manufacturer and, therefore, determine the suitability of any particular type for any desired application. Typical values are illustrated by Table II.

CHOKE COILS

Choke coils are also subject to the deforming stresses due to heavy transient currents and must be properly selected in accordance with the expected duty.

Early types of choke coils were generally furnished without any bracing of the turns and were often badly damaged or at least distorted. For heavy duty applications, modern types are usually provided with some form of bracing to give the desired rigidity. Fig. 6 shows the effect of short circuit current on a braced type of coil, tested to

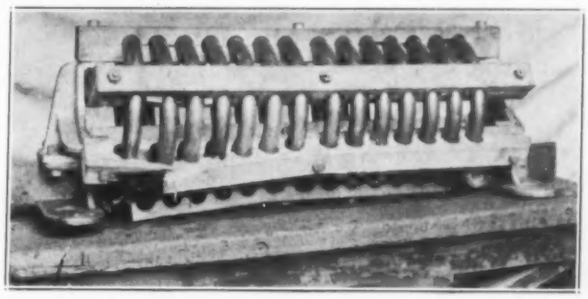

FIG. 6

the point of destruction. Data of this nature are necessary in order to determine the safe limits of operation for various apparatus.

BUS BARS AND SUPPORTS

If two parallel bars are carrying current, forces of attraction or repulsion between bars are produced, depending on whether the currents are in the same or opposite directions. These forces, which tend to distort the alignment of the bars, are transmitted to the bus bar supports, producing stresses due to tension, compression or bending. The possible effects of heavy current transients are shown in Fig. 7.

Electro-magnetic stresses in direct-current busses are readily determined. The calculations of stresses in alternating current busses introduce many additional factors and these must be taken into account if reliable results are to be obtained. Space limitations prevent a presentation in this paper of the

methods employed, but these are available in the references appended.

No important bus installation should be made without an exact analysis of the possible stresses due to short circuit transients. Approximate methods of calculation, used in the past, may lead to erroneous results, due to possible resonant conditions, resulting from the relative forced and natural periods of vibration of different types of structures.

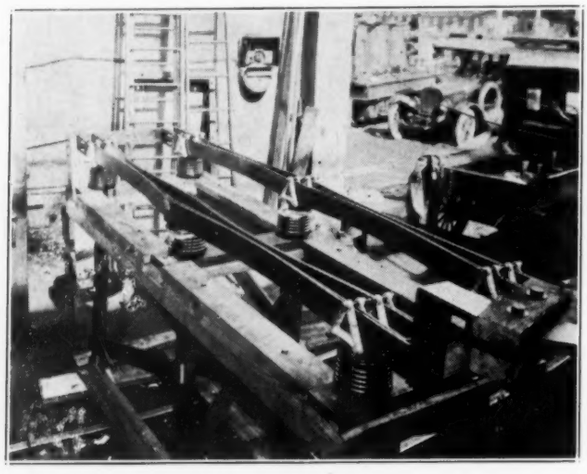

FIG. 7.

INSULATED CABLES

Cables are ordinarily selected on the basis of energy loss or heating corresponding to normal loading of feeders. During severe transient conditions, excessive heating may be produced which would cause a rapid deterioration of the insulation.

Parallel single conductor cables are subject to mutual forces of repulsion or attraction and must be securely supported to prevent movement.

In three conductor cables, the phases have a relatively small separation and high internal stresses may be developed, during short circuits, which tend to burst the outer envelope.

TABLE III

APPROXIMATE SHORT TIME CURRENT CARRYING CAPACITIES OF CABLES

Size Cable	Amperes for One Second Insulation		
	Rubber	Varnished Cambric	Paper
#4	1830	2000	2200
1/0	4660	5120	5600
4/0	9320	10240	11200
300000	13200	14500	15900
400000	17600	19300	21200
500000	22000	24100	26400
750000	33000	36200	39600
1000000	44000	48300	52900
1500000	66000	72500	79300
2000000	88000	96500	105000

½ Second Capacity.
Multiply above values by 1.41.
¼ Second Capacity.
Multiply above values by 2.

Table III gives the approximate short-time current-carrying capacities of several sizes and types of cables. In selecting cable to meet predetermined transient duties, it is probably advisable to limit the maximum r.m.s. current to the ¼ second ratings given; this limitation applies more particularly, however, to 3-conductor than to single-conductor cables, due to the internal stresses mentioned.

REACTORS

With normal rated circuit voltage maintained at its terminals, a reactor is generally guaranteed to withstand the resulting current, limited only by its inherent reactance, for a certain specified time—e.g., assuming an air-core design, which is not subject to magnetic saturation, a 3% reactor must withstand 33 1/3 times normal current, a 5% reactor 20 times normal, etc. This also means that the reactor is subjected to 33 1/3 or 20, etc., times its normal rated voltage; it must, therefore, be properly designed to meet the transient stresses due to both current and voltage.

Forces of attraction or repulsion are also set up between adjacent reactors and suitable bracing to prevent movement will be necessary, unless the minimum spacing recommended by the manufacturer can be satisfied.

Reactors are sometimes located adjacent to magnetic material—such as, I-beams, re-inforcement in concrete, etc.—and the proper clearances recommended by the manufacturer should be maintained, so as to avoid unnecessary heating in such material, due to magnetic flux, during both normal and transient conditions.

LIGHTNING ARRESTERS

The lightning arrester is a device which is intended to operate during high voltage transients of extremely short duration, measured in fractions of micro-seconds. It is not designed to withstand dynamic current and its characteristics must, therefore, be such that it will not pass current within the usual variations of the system voltage.

A transient condition inimical to the arrester may be produced in case of a complete loss of load, due to tripping of feeder switches. This is particularly true in hydro-electric installations, where voltages of 200% of normal have developed within two or three seconds after breakers have opened.

Turbine units have closer speed regulation and the danger of high voltage in steam installations is, therefore, considerably less. In no case should it be overlooked, however, and suitable voltage limiting devices should be used where necessary.

TRANSIENTS DUE TO "GROUNDS"

If the neutral point of a three-phase system is not fixed with respect to zero earth potential, a ground on one phase may raise the potential of the other two phases considerably above normal. The greatest danger to apparatus from this class of transients is occasioned by arcing grounds caused, for example, by repeated flash-overs on defective line insulators; the voltages produced in such cases may be several hundred per cent of normal and occur not only in the faulty circuit but simultaneously in all parts of the system, so that a large amount of equipment is subject to immediate damage or to consequent failures from weakened insulation.

With the neutral point grounded, arcing grounds and dangerous over-voltages are eliminated; each "ground" becomes a phase-to-neutral short circuit which can be removed by proper relay protection.

Space precludes any discussion of the relative merits of grounded neutral versus ungrounded neutral systems, but attention is called to the very general adoption of the former by the Utility companies, with resulting improvement in system operation.

TRANSIENTS DUE TO SWITCHING AND LIGHTNING

Although abnormal transients may be produced by switching operations, it has been found that their effects are of minor importance compared with those due to lightning. Recent developments in devices for actually measuring the induced voltages produced by the latter, supplemented by laboratory tests with the so-called "lightning generator" are giving data which have clarified much which, in the past, was mainly conjectural.

The voltage required to break down any given insulation is a function of time. Insulation which will fail at a given voltage under a standard 60 cycle, one-minute test will withstand transient impulse voltages of much greater magnitude; the ratio of these breakdown values is termed "Impulse Ratio."

Our knowledge of the impulse breakdown of various classes of equipment for different kinds of impulse waves is rapidly increasing. By proper selection of relative impulse strengths of connected apparatus, such as, generators, transformers, lines, etc., failures—when they do occur—may be localized at points where they will be of least consequence.

EXAMPLES OF APPLICATION

The following examples are given to illustrate the general method of calculating some of the short circuit transients which may occur in different types of installations and also to illustrate how certain equipment is selected to meet these transient duties. Line to line short circuits are assumed in each case.

Fig. 8 indicates a generating station containing three turbo-alternators operating in parallel and supplying power to feeders of various capacities which go to different points of distribution.

The per cent reactance of each piece of apparatus is given in terms of its individual kv-a. rating. In order to combine these percentage values in any manner, they must be first expressed in terms of a common kv-a. base, which is preferably the total synchronous kv-a. capacity of the system —in this case, 19,375 kv-a. The corresponding per cent values expressed in this manner are given in the parentheses.

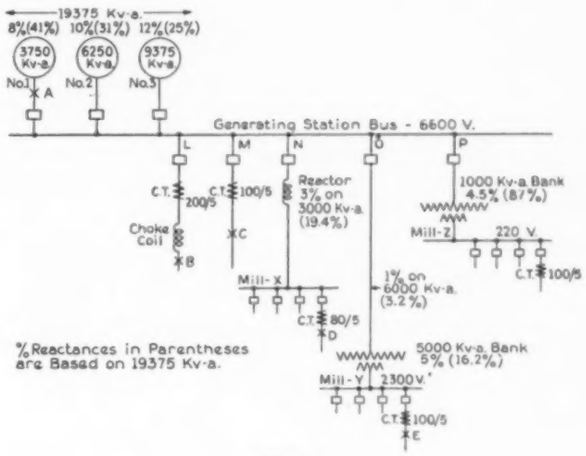

FIG. 8.

Table IV gives data taken from average decrement curves for line-to-line short circuits, showing the total r.m.s. values of current—expressed in number of times normal, full load current—at different intervals of time. This table is used in the following calculations.

Based on 19,375 kv-a., the normal currents in the system are:

$$\text{At } 6600 \text{ volts} = \frac{19375 \times 1000}{6600 \times 1.73} = 1690 \text{ amperes}$$

$$\text{At } 2300 \text{ volts} = \frac{19375 \times 1000}{2300 \times 1.73} = 4850 \text{ amperes}$$

$$\text{At } 220 \text{ volts} = \frac{19375 \times 1000}{220 \times 1.73} = 50800 \text{ amperes}$$

SHORT CIRCUITS AT "A"

The combined reactance of generators No. 2 and No. 3 are: $\dfrac{1}{\frac{1}{31}+\frac{1}{25}} = 13.8\%$ based on 19375 kv-a.

TABLE IV

SYSTEM SHORT-CIRCUIT CURRENT FACTORS APPLICABLE TO SINGLE PHASE LINE TO LINE SHORT CIRCUITS ON THREE PHASE SYSTEMS

Time in Seconds From Instant of Short Circuit	R.M.S. Total Current Expressed in Number of Times Full Load Current for Various per cent Reactance											
	5%	8%	10%	12%	15%	20%	30%	40%	50%	60%	75%	100%
0.00	35.00	22.02	17.82	14.88	12.00	9.01	6.00	4.52	3.54	2.95	2.36	1.74
0.05	21.80	14.00	11.46	9.69	7.95	6.07	4.12	3.15	2.49	2.08	1.67	1.23
0.08	18.53	12.02	9.90	8.43	7.01	5.38	3.69	2.84	2.25	1.90	1.51	1.11
0.10	16.93	11.10	9.18	7.85	6.56	5.07	3.50	2.70	2.16	1.80	1.44	1.06
0.15	13.92	9.32	7.80	6.75	5.87	4.50	3.16	2.47	1.99	1.67	1.35	0.98
0.20	12.30	8.36	7.09	6.19	5.31	4.21	3.00	2.36	1.90	1.60	1.29	0.94
0.25	11.08	7.66	6.55	5.76	5.00	4.00	2.89	2.29	1.86	1.56	1.26	0.92
0.30	10.18	7.15	6.15	5.45	4.79	3.86	2.82	2.25	1.82	1.54	1.24	0.90
0.40	8.96	6.45	5.62	5.04	4.48	3.67	2.73	2.19	1.79	1.51	1.21	0.89
0.50	8.01	5.89	5.20	4.71	4.24	3.51	2.66	2.15	1.77	1.49	1.20	0.87
0.70	6.73	5.15	4.63	4.27	3.92	3.31	2.57	2.10	1.73	1.47	1.18	0.86
1.00	5.46	4.42	4.08	3.84	3.61	3.12	2.48	2.05	1.70	1.45	1.16	0.84
1.50	4.41	3.81	3.62	3.48	3.35	2.95	2.40	2.01	1.68	1.43	1.15	0.83
2.00	3.69	3.40	3.30	3.23	3.17	2.84	2.35	1.98	1.66	1.41	1.14	0.82
3.00	3.00	3.00	3.00	3.00	3.00	2.73	2.30	1.95	1.64	1.40	1.13	0.81

Assume that the generators are equipped with differential protection and that their breakers will open in 0.15 second; interpolating for 13.8% reactance in Table IV, the short circuit currents from the bus to the fault are:

at 0.00 second — 13 x 1690 = 22000 amperes
at 0.15 second — 6.2 x 1690 = 10500 amperes

SHORT CIRCUIT AT "B" OR "C"

The combined reactance of generators No. 1, No. 2 and No. 3 is: $\frac{1}{\frac{1}{41}+\frac{1}{31}+\frac{1}{25}} = 10.3\%$ based on 19375 kv-a.

Assume that the breakers of feeders M and N open in 0.30 second; then from Table IV, the short circuit currents are:

at 0.00 second — 17 x 1690 = 28700 amperes
at 0.30 second — 6 x 1690 = 10100 amperes

SHORT CIRCUIT AT "D"

The combined reactance of generators and reactor is:

10.3 + 19.4 = 29.7% based on 19375 kv-a.

Assume that breakers in Mill X open in 0.15 seconds; then from Table IV, the short circuit currents are:

at 0.00 second — 6.1 x 1690 = 10300 amperes
at 0.15 second — 3.15 x 1690 = 5300 amperes

This example illustrates how the short circuit duty can be reduced at points of distribution, where it is generally undesirable to install expensive switching equipment comparable to that used in the main generating station.

SHORT CIRCUIT AT "E"

The combined reactance of generators, feeder and transformer bank is:

10.3 + 3.2 + 16.2 = 29.7% based on 19375 kv-a. (i.e.—same as for "D")

Assume that breakers in Mill Y will open in 0.15 second; then from Table IV, the short circuit currents are:

at 0.00 second — 6.1 x 4850 = 29600 amperes
at 0.15 second — 3.15 x 4850 = 15300 amperes

SHORT CIRCUIT AT "F"

The combined reactance of generators and transformer bank is:

10.3 + 87 = 97.3% based on 19375 kv-a.

Assume that breakers in Mill Z will open in 0.08 second; then from Table IV, the theoretical short circuit currents would be:

at 0.00 second — 1.77 x 50800 = 90000 amperes
at 0.08 second — 1.15 x 50800 = 58400 amperes

In cases involving short circuits at voltages of 600 volts or less, it is usually considered safe to discount considerably the calculated values. Experience indicates that the additional reactances of buses, cables, oil and disconnecting switch loops and resistance of the short circuit contact, limit the currents to values which rarely exceed about 20,000 amperes.

The results of the preceeding calculations are tabulated in Table V.

TABLE V

Location of Short Circuit	Calculated R.M.S. Values of Short Circuit Current at Various Time Intervals			
	0.00″	0.08″	0.15″	0.30″
A	22000		10500	
B	28700			10100
C	28700			10100
D	10300		5300	
E	29600		15300	
F	90000	58400		

SELECTION OF OIL CIRCUIT BREAKERS

The generator breakers and main 6600 volt feeder breakers might vary in ampere capacity from 400 to 1200 amperes. For any of these ratings, the short-time current-carrying capacities and rupturing capacity of the type 100 breaker in Table VI satisfy the duties calculated for 6600 volt short circuits at "A," "B" and "C."

The type 200 breaker guarantees in Table VI satisfy both the 6600 volt duties in Mill X and the 2300 volt duties in Mill Y.

In Mill Z, the calculated short-circuit duties would be discounted to a maximum of 20,000 amperes, which could be safely handled by the type 300 switch of Table VI.

SELECTION OF CURRENT TRANSFORMERS

In the selection of current transformers from Table II, it is assumed that the volt-ampere burdens

TABLE VI

Type	Rated Volts	Rated Amp.	Rated Short Time Capacity in R.M.S. Amp. One Second	Five Seconds	Rated Interrupting Capacity in R.M.S. Amperes at Various Voltages 600	2500	2300	7500	6600
100	15000	400	40000	20000				10500	12000
100	15000	600	60000	30000				10500	12000
100	15000	800	60000	40000				10500	12000
100	15000	1200	60000	60000				10500	12000
200	15000	400	40000	20000		17500	19000	5300	6000
200	15000	600	40000	30000		17500	19000	5300	6000
200	15000	800	40000	40000		17500	19000	5300	6000
300	600	400	20000	20000	20000				
300	600	600	20000	20000	20000				
300	600	800	20000	20000	20000				

are, in general, such as to give the desired accuracy for the proposed application. The maximum permissible current is assumed to be the ¼ second rating—or twice the one-second ratings given in the table.

For the generator circuits, which vary in capacity from 400 to 1000 amperes, the 6600 volt transformers of types 4 and 6 or the 15,000 volt transformers of types 7 and 9 easily satisfy the short-circuit conditions at "A."

200 Ampere transformers, type 4 or 7, are suitable for Feeder L. Transformers of 100 ampere rating or less in these types would not meet the instantaneous duty given for short circuits at "B" or "C" and it would, therefore, be necessary to use the types 5 or 8, which would be suitable for ratings of not less than 50 amperes.

At Mill X, type 4 or type 7 transformers in ratings of 80 amperes or more satisfy the short-circuit duties at "D."

At Mill Y, type 1 transformers in capacities below 250 amperes would not be suitable. For the 100 ampere rating indicated, it would be necessary to use the type 2; if the volt-ampere burden should be such that desired accuracy cannot be obtained with this design, type 5 would be chosen.

The assumption has been made that actual short-circuit currents at Mill Z will not exceed 20,000 amperes; this value might be practically sustained and type 1 transformers in capacities of 250 amperes or greater would, therefore, be required. For lower ampere capacities, type 2 or type 5 would probably be selected.

CONCLUSIONS

Modern electrical equipment, properly designed and applied, has a high degree of reliability. Every piece of apparatus, however, is subject to definite limitations and the intent of this paper has been to show that, in selecting equipment, account must be taken of transient as well as normal duties in order to realize satisfactory plant operation.

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*The Invisible Relay in Vari-Time Control**

By L. A. WATSON, C. H. RIPPL and W. H. WILLIAMS†

THERE is an old saying "Time is a great cure-all" and who would have imagined, just a few years ago, that this old maxim might, after all, have some bearing on the question of automatic control of motors in a mill or industrial plant.

Yet, so it turns out, that at the present writing there is the general demand for and the apparent necessity of that great cure-all "TIME" as the fundamental factor in automatic control of electric motors. Of course, in the general reference to this subject we all have drifted into the habit of saying "Time Limit Acceleration."

After all, that is simply an expansion or evolution of the basic idea of "TIME" as being the real thing to consider and after reaching that point the natural sequential thought is to find some good practical means of controlling the "TIME" of acceleration. So, as one of the meanings of Control is to maintain within certain limits, we naturally come to the distinctive designation "Time Limit Control."

In other words, we want "Time Limit." We want control of the "time limit" and by "control" in this sense we mean ways and methods, of adjusting the "TIME Limit" and finally we come to the ultimately desired objective, viz—Adjustable Time Limit Acceleration in Automatic Magnetic Controllers.

We, therefore, present for your consideration and discussion a new design of Magnetic Contactor which, to all appearances, is simply a Contactor but which actually contains within its parts the desirable feature of adjustable timing with the adjustment for different time values easily made.

The accompanying view as per Figure 1 shows the VARI-TIME Contactor. The dotted lines show the principal parts common to any design of single pole magnetic contactor, viz: "A", the main contact arm, "B", the auxiliary arm, "C", the copper contact tips, "D", the stationary arm supporting one of the tips, "E", the frame and "F", the magnet coil. In this Figure 1 the blowout coil and arc shields with magnetic blowout ears have been omitted as not being pertinent to the subject of this paper.

Noting Figure 1 further, we see, in more prominent detail, "G" the core of the magnetic circuit and "H" the adjusting screw by which the main contact arm "A" is maintained in certain definite positions relative to the front end of core "G". In other words, the air-gap "J" is variable within certain limits.

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*Presented before Birmingham District Section, A. I. & S. E. E., March 31, 1928.

†L. A. Watson, Chief Engineer; C. H. Rippl, Development Engineer; W. H. Williams, Sales Manager, The Clark Controller Company, Cleveland, Ohio.

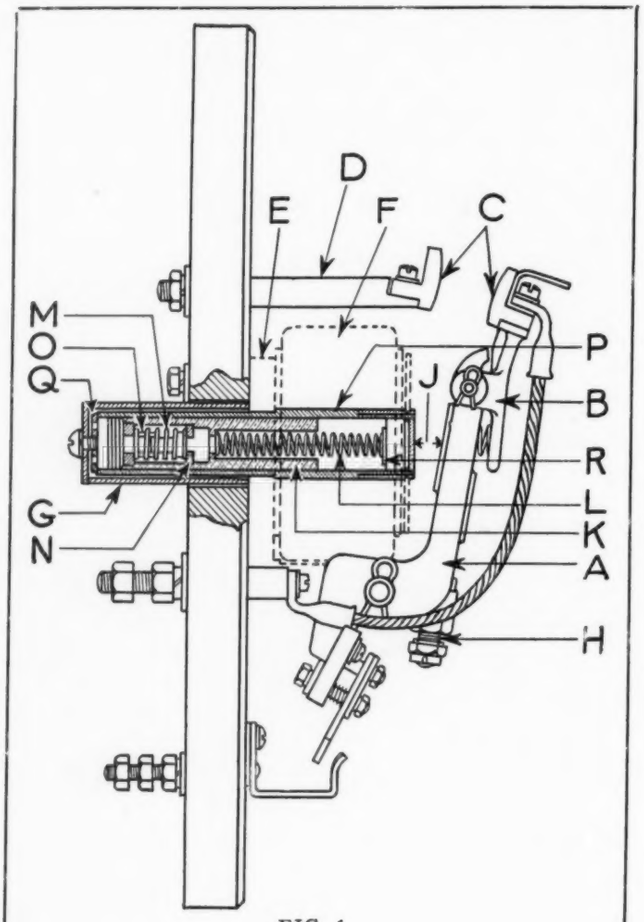

FIG. 1.

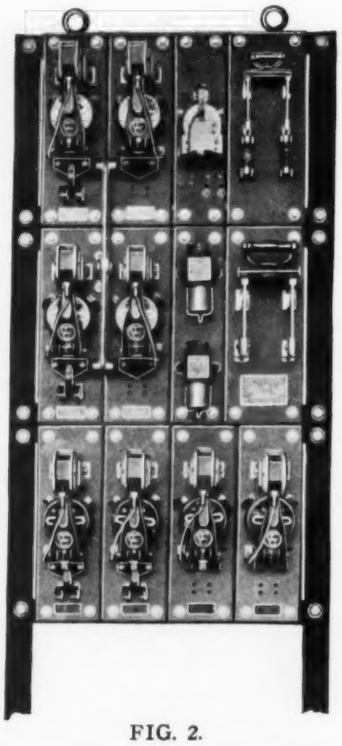

FIG. 2.

Now referring to the core "G" which is shown in cross section, we see a cylindrical steel plug "K", a front spring "L", a rear spring "M", a valve "N", of non-magnetic metal, and valve seat "O", also non-magnetic. "P" is the brass shell which completely envelopes the aforementioned parts and "Q" is the threaded plug which completely closes the rear end of shell "P" and which, further, is soldered in place thus making the entire core a hermetically sealed, air-tight, dust and moisture proof device. Just before sealing the core a certain quantity of very thin oil is placed inside the shell and with the core in place as shown we now have the adjustable time limit accelerating contactor which functions as follows:

To start let us energize the magnet coil "F" by applying any standard D.C. voltage for which the coil is designed. The normal position of Plug "K" is to the rear of core as shown. When Coil "F" is energized the Plug "K" travels forward due to

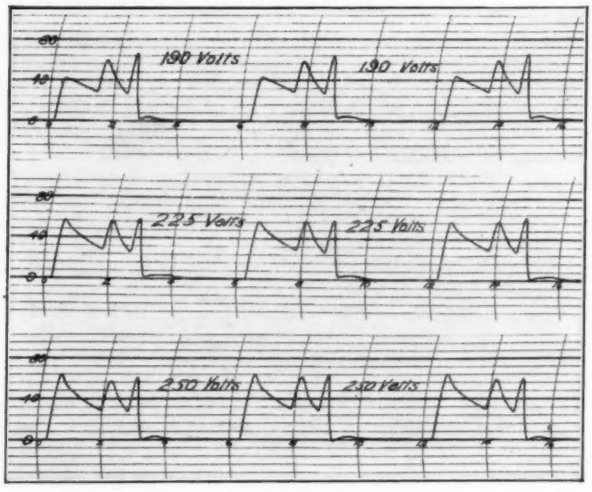

FIG. 3.

the old principal of magnetic solenoids. As the Plug "K" approaches the front end of core "G" the magnetic lines of force are redirected until the distribution is such as to produce sufficient impelling force to draw the main contact arm to the front end of core thus closing the contactor.

Naturally, the amount of the air-gap determines the extent to which the travelling plug has to approach the front end of the core before there is sufficient concentration of lines of force to pull the arm closed and so the timing of the contactor is obtained by adjusting the air-gap.

The function of the valve mechanism at the rear of the travelling plug is to compensate for variation in the normal line voltage. Voltage higher than normal will tend to move the plug forward more rapidly than normal but in that case the pressure of the oil on front of valve "N" will partially close the opening through which the oil must pass and hence the rate of movement of plug is controlled in such a way as to maintain a uniform timing over a wide range of applied voltage.

Thorough research and development have resulted in providing all necessary details of design

as for instance at the front inside end of core there is a non-magnetic ring "R" provided so that the travelling core cannot be held in forward position either by residual magnetism or by suction.

Utilizing this adjustable time limit Contactor for the eccelerating points of a Reversing or Non-Reversing Automatic Control Board, any practical load or service condition can be taken care of. Contactors of this design have been built to show the extreme possibilities of timing and the range covered is from practically instantaneous closing to a time delay of seventy-five seconds. This total

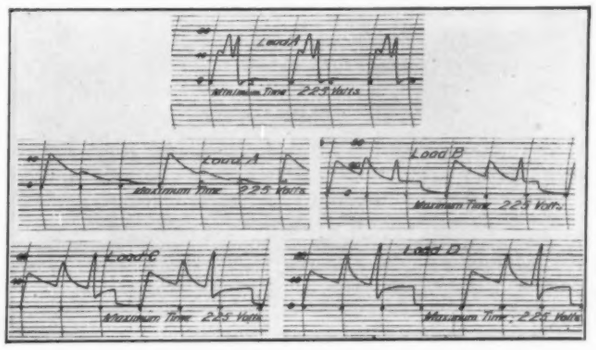

FIG. 4.

range is obtained by substitution of various cores in the same contactor.

Figure 2 shows a complete reversing magnetic controller using the same general design of contactor for reversing and for acceleration. The accelerating contactors have the timing core while the reversing and main line contactors have solid cores. The magnet coils on all contactors, either reversing or accelerating, are the same.

Figure 3 shows three graphic records of acceleration with the same time adjustment and with different applied voltages in each case. The magnet coils used on the controller from which the curves were obtained, were standard 230 Volt D.C. coils. From these curves it may be seen how constant the

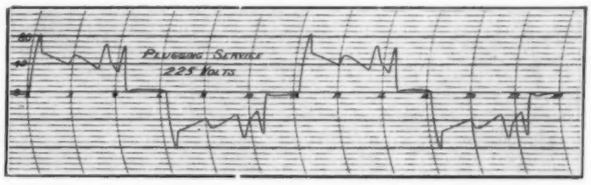

FIG. 5.

timing remains over a range of 190 Volts to 250 Volts.

In Figure 4 is illustrated, by two graphic records, the difference that can be obtained from minimum to maximum time acceleration with the same load "A". The remaining three curves were made with the same maximum time adjustment, same applied voltage but with increasing loads "B", "C" and "D". The load on motor has no effect. This is purely a Time Limit Acceleration proposition.

Figure 5 is a graphic record of acceleration in each direction of rotation of motor. Note the extreme uniformity of acceleration.

DISCUSSION

James Sayer*: Do you make A.C. Contactors having the same features?

W. H. Williams: No—this idea so far is developed only for direct current service.

E. S. Lammers†: .Will check valve in plunger act as release valve when switch opens?

W. H. Williams: Yes. The check valve is held wide open by the timing spring at all times when the plunger is not moving forward. This allows the plunger to reset quickly.

E. S. Lammers: Is there enough cushioning in release valve to prevent heavy jar or blow when plunger returns to rear of core?

W. H. Williams: The cushioning of the plunger in resetting is done by the oil trapped between the plunger and the plug in the rear end of the core tube. The oil cushion softens the blow.

James Sayer: Does temperature of oil vary the timing of the contactor?

W. H. Williams: A change in the temperature of the oil is always accompanied by a change in the temperature of the coil and the metals of which the core is made. These changes tend to neutralize each other so that the variation in timing is slight—approximately 10% from cold to hot oil at the normal adjustment of the switch. At the minimum time adjustment the variation in percentage is slightly more although the actual time variation is small.

H. C. Uhl‡: What is the timing range with any one core?

W. H. Williams: The timing range varies from 2 to 1 in a 1 second core to 4 to 1 in a 75 second core.

E. C. Winters§: Does the oil act to control travel of plug or just as a lubricant? Does the oil or air control the timing?

W. H. Williams: The oil controls the timing and also acts as a lubricant. The air space in the core is used only to allow for expansion of the oil.

A. J. Standing**: To what extent are the parts on the board interchangeable? How are the coils wound—style and size of wire?

W. H. Williams: On the mill type board all parts on the contactors are interchangeable except the frame, core and arm stop stud. All parts on a continuous capacity board are interchangeable except the frame, core, main arm and arm stop stud.

The coils are machine wound on a fiber tube with cotton thread insulation interwoven between the layers of wire and wound around the coil. Fibre heads are added after the coil is impregnated. The wire is enamel insulated and is No. 30 on mill boards and No. 31 on continuous boards. Of course, heavier wire will be used on larger sizes of contactors.

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‡Elec. Engr., General Electric Co., Atlanta, Ga.

§Elec. Engr., Sloss Sheffield Steel Co., Birmingham, Ala.

**Elec. Supt., Bethlehem Steel Co., Bethlehem, Pa.

W. W. Garrett†: In what capacities will the contactor be built?

W. H. Williams: The present program is to make 100, 200 and 400 ampere continuous capacity contactors. This is not to be taken as definitely settled, we may change our program.

W. C. Suppler‡: Are you using the same tips on the long time test (354,000 operations to date) on the contactor?

W. H. Williams: The same tips were used throughout the test and appear to be good for as many more operations. The test was stopped at this point in order to make other tests on the same switch. The switch with the same tips will be put back on the test and run to a finish.

W. C. Suppler: What difference in timing will be caused if the arm pin wears?

W. H. Williams: If the arm pin wears considerably the timing of the switch will be increased slightly. However the wear on the arm pin is very slow and may be neutralized by setting up the time adjustment when necessary.

A. L. Lemon§: Do you have only one coil on the one size contactor? How do you take care of conditions requiring very rapid acceleration?

W. H. Williams: We use a continuous capacity coil where necessary. Where continuous capacity is not required we use an 80% coil but we never use different coils on the same board. The 100% and 80% coils are of different colors to avoid confusion.

†Engr., Tests, T. C. I. R. R. Co., Birmingham, Ala.

‡Elec. Supt., Ensley Plant, T. C. I. R. R., Ensley, Ala.

§Elec. Engr., General Machinery Co., Birmingham, Ala.

For very rapid acceleration we use a very rapid core. The timing cores can be made for various operating conditions from 1/10 second maximum up to 75 seconds or more.

W. C. Suppler: Is the board designed to be built for any constant time conditions?

W. H. Williams: By using the proper cores the switches can be adjusted and locked for a constant time giving a board on which voltage and temperature changes have practically no effect.

Cliff Ginsley: To what extent can this contactor be applied to dynamic lowering?

W. H. Williams: The contactor is well adapted to be used in dynamic lowering controllers when properly connected in the circuit.

Carl Hogle*: Can the oil in the cylinder become emulsified after long service?

W. H. Williams: Due to the fact that we use a highly refined clean dry oil sealed in a tube which contains only a very small volume of air, we do not anticipate any trouble from emulsification of the oil.

A. J. Standing: I believe a good many of we fellows in the mills thought that all the good new ideas on magnetic controllers had been worked out. Manufacturers of this line of equipment deserve credit for the progress made in this work. I certainly want to state that when any concern has the fortitude to pioneer such a brand new idea as has been shown tonight they deserve at least a trial from each of us to show whether or not they have hit the mark.

*Chief Engr., Power House, T. C. I. R. R. Co., Birmingham, Ala.

*Characteristics of Cold Rolling Mill Machinery**

By J. H. VAN CAMPEN†

THERE is a very great demand today for more refinements on rolled material, such as tolerances, finish and sizes.

Such refinements are carried to the greatest possible degree on material produced by cold rolling mills.

The modern cold rolling mill today is a precision mill from every angle, requiring a very high grade of workmanship to build, and great care and skill in order to operate successfully.

There are two types of mills used for cold rolling, one is the standard two-high type, which is the most common; the other is the backed-up type employing small working rolls, which are supported by larger rolls. This last type of mill has become very much in favor during the past two years, and will no doubt supercede the two-high type in the future for heavy duty cold rolling mill service.

The mills are required to make very heavy reductions, therefore they have to be built heavy in order to insure the greatest rigidity for production of accurate material.

Roll housings are usually of close grain cast iron, due to the fact that there is less spring or stretch in cast iron than steel, therefore not so much allowance has to be made for spring of mill during rolling.

The working rolls used today are mostly hardened tool steel, heat-treated, ground and polished, with bodies having a hardness of approximately one hundred (100) sclerescope.

These rolls are very costly and their forging, heat-treatment and grinding require the greatest skill known to the art.

On the smaller units of cold rolling mills, hand wheel operated screw downs are regularly used; on mills with approximately 16-inch diameter rolls and up, motor operated screw downs are more desirable.

The screw down motors are usually operated by an inching control for fine adjustment, the ratio between motors and mill screws being such that one revolution of the motor will give one-half thousand inch vertical movement of the working roll in the mill.

*Presented before the A. I. & S. E. E. at their Inspection trip of the E. W. Bliss Co. Plant at Salem, Ohio, June 2, 1928.

†Chief Engr., E. W. Bliss Co., Salem Ohio.

A great number of cold mills built today are equipped with anti-friction bearings on the roll necks.

There is a very great economy by their use, due to the saving in power, which is approximately 40 per cent, but this economy is actually a by-product. The greatest advantage gained by using such type roll neck bearing is, they eliminate the heating of roll necks, thus preventing the swelling of the out-

dred and fifty feet per minute, now mills are built with speeds up to three hundred and seventy-five feet per minute.

The limit to speed for cold rolling steel, when considering reduction of not less than twelve to fifteen per cent, is the ability of the hardened tool steel rolls to stand the strain which is produced from temperature rise developed from rolling.

Guests in attendance at the Inspection Trip of the E. W. Bliss Company's Plant, Salem, Ohio, held June 2nd, 1928, under the Auspices of the Association of Iron & Steel Electrical Engineers.

side ends of the roll body, giving a better control of the roll shape, which will produce a more accurate product from the mill.

Also, it is possible to roll material at very much higher speeds and consequently greatly increasing the tonnage from the mills.

Due to the use of anti-friction bearings on roll necks, it is very desirable that the mill be equipped with universal spindles for transmitting the power from gear reduction unit to mill in order to eliminate any back lash due to the free running bearings.

This pertains more to the backed-up type of cold mill where small diameter working rolls are used.

In order to better control the mill and deliver the finished product straight and to gauge, the rolls are provided for internal temperature control by means of water circulated through the roll body, or the rolls are given a crown on the body, and sometimes a flame is allowed to play on the body. The amount of control required for the rolls depends upon the condition the material is delivered to the mill and the spring of the mill during rolling.

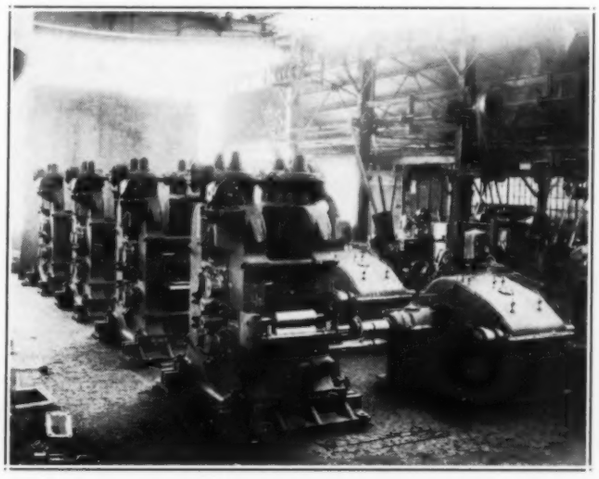

FIG. 1—Bliss 10½" Cluster Mill

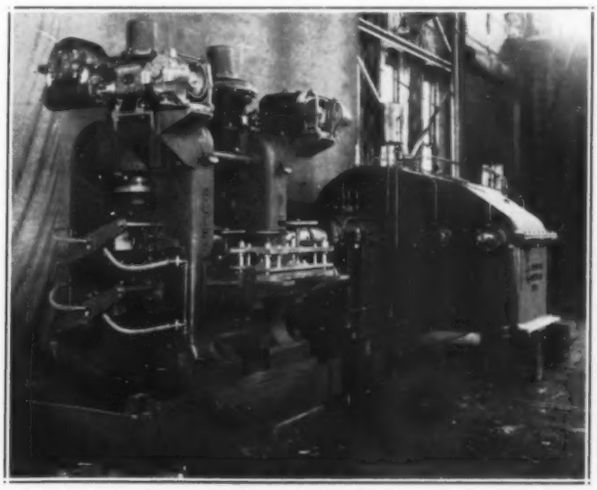

FIG. 2—Bliss 18" 2-High Mill

The gear drive and mill pinions used on cold rolling mills should have the most accurate cut teeth, and preferable double helical in order to insure a very smooth running unit.

If there is any chatter from gears, pinions or spindles this will be transmitted to the material when rolling a high finish product.

The tendency today is to go to higher rolling speeds, where usually on cold mills for steel the rolling speed was about one hundred to two hun-

Great care is given to the proper design of guides and wipers used on cold rolling mills so as to insure the material rolled will not be scratched or marked in any way.

Entering guides are usually wood and brass, the exit guides are brass stripper plates to prevent the material going around the rolls.

In front of the entering guide there is usually provided one or two wipers which the material being rolled passes through before entering the mill.

Also, sometimes wipers are provided for the rolls in order to keep the highly polished roll body clean and eliminate any danger of foreign substances being rolled into the material.

Cold rolling mills are usually arranged as individual units or in tandem. When arranged in tandem there is usually four stands in such a group, and from such arrangement the practice is to get any where from fifty to seventy-five per cent total reduction of the material rolled.

For driving cold mills the most desirable electrical unit is the D. C. variable speed shunt wound motor, continuous duty rated with 40 degree Centigrade temperature rise.

The tendency today is toward the use of three to one motor speeds over the two to one motor speeds.

The control for cold mill drive motors should provide for automatic definite time acceleration, overload relay and low voltage protection, emergency reverse and push buttons for start, jog and stop.

Manually operated field rheostats are usually used and the number of speed points desired depends upon the speed range required on the motors and the conditions of rolling.

*Air Conditioning Equipment**

By WALTER BURR†

MODERN civilization is meeting and solving new problems almost daily. One of these problems is that of furnishing clean air, not only for breathing purposes, but for all industrial purposes.

We all know how essential it is to have pure water and we are beginning to realize how essential it is to have pure air.

The average person takes into his delicate sensitive inner organs more than 720 cubic feet of air in 24 hours.

On account of its abundance and fluidity, it is widely used as a medium for the conveyance of heat. To the human being it conveys heat to the body in cold weather and from the body in warm weather.

In this paper, however, we will deal principally with air conditioning equipment as used for industrial purposes.

The problem of furnishing clean air for cooling purpose in the electrical industry was confronted about the time the steam turbo-generators were developed.

In the earliest stages coke and string filters were tried. Then followed the fabric filter, the air washer and viscous film filter, and now the automatic viscous film filter.

The fabric filter consisted of cloth screen through which the air was forced and of course the foreign matter restricted the openings and the resistance became excessive.

The air washer accomplished its cleaning effect by impingement of dust particle against wet surfaces of eliminator plates, these being used primarily to prevent the entrainment of the water used.

The principle difference between the air washer and the viscous filter is in the medium used to remove the dust particles.

The air washer is particularly adapted to the removal of soot and metallic compound and oily particles. For these particles of dust for which water has no affinity, it is not as effective as a viscous film filter.

The air washer requires considerable floor space and requires more power and more maintenance than most of the viscous filters.

The viscous film principle has long been known for every woman has used oil mops for the collection of dust and floors in public buildings are oiled to keep down the dust.

The viscous film method of air filtration is quite simple. Air being drawn through a device containing a series of deflecting surfaces usually made of metal on the surface of which is a coating of viscous oil. As the air strikes the surface it is deflected but the inertia of the dirt, or foreign matter, causes it to strike and enter the film and retains it in suspension.

The earlier forms of viscous filter consisted of a cell in which were placed V shaped strips, but considerable time was required to clean these strips. Some of the later cells contained copperized rings, some expanded metal and some steel wool held in position between screens.

With the cells installed in groups and supported in metal frame work, the air cleaning was accomplished very effectively, but the work in connection with the cleaning of the filter increased the cost of maintenance and resulted in the development of the automatic type filter.

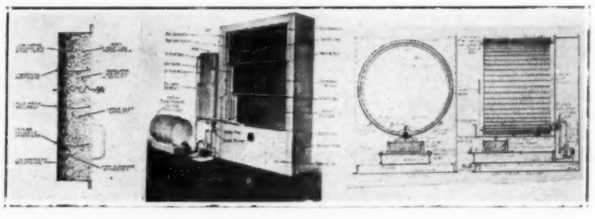

FIG. 1—Reed Cell Type Filter. FIG. 2—Easy Way Filter. Cells so arranged that they can be readily immersed in cleaning solution. FIG. 3—National Air Filter Rotary Type.

There are a number of these on the market at the present time, a description of some of these will be given briefly. This can be accomplished best by the use of several pictures showing viscous air filters of different types.

*Presented before Philadelphia District Section, A. I. & S. E. E., April 7, 1928.

†Elec. Supt., Lukens Steel Company, Coatesville, Pa.

One of the cell type filter units, Fig. 1, is composed of split wire enclosed in a steel frame with steel mesh. The split wire is dipped in lead which protects and binds the media. You will note it is arranged with a graduated variation in density so that the large dust particles are collected first and near the back the finer particles are removed. To secure the maximum efficiency means to secure maximum number of impingements of air against the viscous coated media. About 60% of the dust content is said to be removed by the first impingement and 60% of the remainder in the next and so on to the infinity.

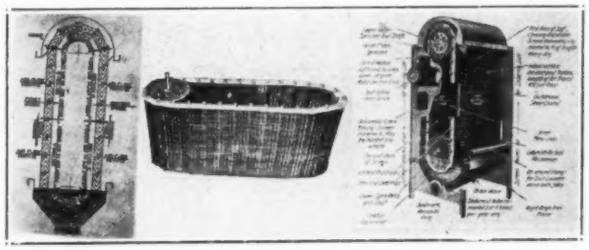

FIG. 4—Principle of operation as used in Phoenix Constant Effect Air Filter. FIG. 5—Rotating Screen as used in the Phoenix Constant Effect Air Filter. FIG. 6—Section through Phoenix Constant Effect Air Filter.

The cells can be arranged in frames or racks built up in the most convenient form for each installation.

It is interesting to note that viscous filters are now being used extensively in the intake lines to air compressors and even in the cold air intake to the hot air heaters in private homes. To clean the cell type filters, Fig. 2, it is necessary to remove them from the frames and immerse them in oil or in steam cleaning tanks where the dirt is removed. Operating

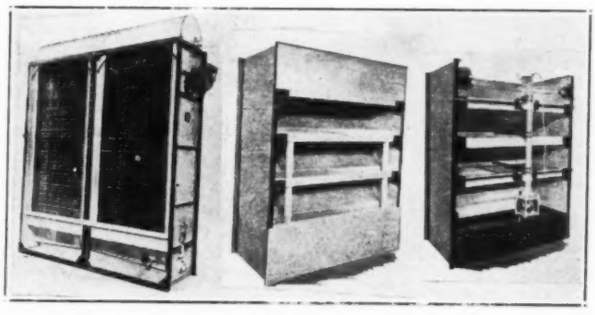

FIG. 7—Two sections of Phoenix Constant Effect Air Filter. FIG. 8—Midwest horizontal Self-Cleaning Air Filter. FIG. 9—Pump and spray pipe on Midwest Filter.

conditions determine to a large extent how often this is necessary, it varying from 4 to 12 weeks usually. The cell after being cleaned is dipped in the viscous solution and is again ready for service. One of the earliest forms of automatic viscous filters, Fig. 3, was shown at our Chicago Convention two years ago. This is a rotary type filter, the air being drawn in through the drum which consists of a filter media supported by an inner and an outer screen, the screen being supported by the rods. One end of the drum is enclosed, the clean air being discharged at the opposite end into the fan chamber. At the lowest point in the filter an oil distributor pipe permits oil to percolate through the filter counter current to the air flow. The join between the rotating and stationary element is sealed with a flexible seal.

When space is the determining requisite, another filter, Fig. 4, is available, which resembled the well known rotating water screen. This screen consists of die formed plates secured in place by cross rods. It is driven by a small motor connected to the top sprocket. The screen moves only about one-sixth of its entire length each day. For each square foot of screen area there is about 117 ft. of viscous coated area against which the air impinges and the air is divided into 1800 separate paths. See Fig. 5.

The cleaning solution is in a reservoir in the bottom of the frame. As the screen passes through this bath the sediment is dropped to the bottom in a trough in which is a screw conveyor driven by a small motor. Periodically this motor should be started and the sediment removed from the reservoir.

With all these various types it is very essential that all joints be made air tight.

Another type of automatic viscous air filter takes advantage of the fact that the bulk of the dust in the air tends to accumulate at the point of entrance

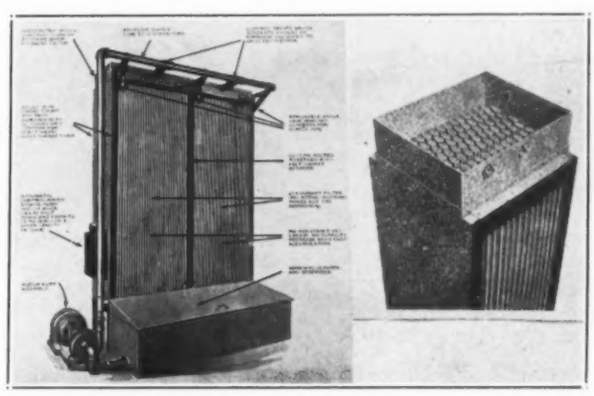

FIG. 10—Reed streamline distributor showing arrangement of forms. FIG. 11—Completely assembled Reed Streamline Automatic Air Filter.

and have arranged viscous coated baffle plates against which the air first impinges and is deflected upward through viscous coated cell filters arranged in a horizontal position. These cells are cleaned by means of a pump which feeds the viscous solution through a header pipe into a flooding pipe and onto the cell filter. This flood pipe travels about 8″ per minute during washing. Only one row of cells is cleaned at a time. A baffle plate prevents the flow of air through that portion of the filter recently subject to the viscous solution. This solution flows by gravity to a reservoir at the bottom of the filter and the dirt settles to the bottom where it is removed periodically.

Recently there has been put on the market an automatic viscous filter which makes use of a distributor which consists of staggered rows of stream line forms. The peculiar contour of these forms makes it possible to present an unusually large area of viscous coated surface for the entrapment of dust.

The viscous solution flows down over these forms and washes the dirt down to the cleaner which con-

sists of a specially knitted pad similar to the type used in power plants for cleaning lubricating oil. In this filter nothing moves but the viscous solution which flows down the forms.

With the increase in capacity of generating equipment and the use of slow speed reversing motors there is a growing demand for air filters which will supply clean air for ventilating purposes for such equipment.

This, however, constitutes only a small portion of the entire field for all modern hotels, theaters, railroad terminals and in fact all places where large numbers of people are assembled are now being provided with these filters so that at the present time there is a large field for successful air filters

DISCUSSION

George J. Walz*: The equipment, which Mr. Burr has covered in his intresting paper, I am sure includes the most modern types of air filters. All the large generators and main roll motors at the plant with which I am connected have their air cleaned with water spray air filters. It is a very satisfactory filter except that it has one serious disadvantage; in real cold weather it will freeze up, but it has the very important advantage over most other types, which only filter the air, of also cooling it, which is worth a great deal, when applied to electrical equipment.

D. M. Petty†: I cannot speak so much from experience, but I want to point out a few things. The air filter has the advantage of taking dirt out of the air, but it lacks one of the essential qualities for cooling air: it is not humidified, which is an important factor. One of the things we frequently forget in connection with an air filter, is that it never takes all the dirt out. Each time it hits against one of those planes 60% of the dirt is taken out, the other 40% remains. You never get it all out. Cleaning the cooling air on a large unit merely postpones the time of filling it with dirt. It does not eliminate the dirt.

I think that can be used to very considerable advantage in many cases, but I think the ideal situation where you want to take fresh air in all the time is to use an oil cleaner to take out the dirt and a water spray to cool and humidify it.

George J. Walz: Another serious disadvantage of the water spray filter is that all the metallic parts will corrode in a very short time. It seems that the alternate wetting and drying, coupled with the impact of the water stream, does break up and corrode all the sheet metal parts very rapidly, but we have tried putting in heavy sheet copper screens and baffle plates, and I believe they have been with us now about a year and a half. Of course, in these particular filters, described by Mr. Burr, the corrosion or erosion, is entirely eliminated.

W. H. Burr: Mr. Petty has mentioned one thing on which I did not give you much information. In taking the air from the atmosphere encountered around Steel Mills you will find as high as two pounds of dirt collected in a day in the intake of a 1000 CFM air compressor. The total cost of operation of air conditioning equipment on a 3750 HP motor is around $215 to $225 a year. The velocity of air through the filter varies from 400 to 450 feet per minute according to the installation. The pressure drop through the filter varies from 1/4 lb. to 4/10 lb. depending on the velocity of air and condition of the filter.

D. M. Petty: Cleaning the intake air for air compressors I think would be a great improvement.

P. L. Pryibil*: I happened to learn about this paper to be read by Mr. Burr, and being interested, I wrote to your secretary for an invitation to the meeting, which he very kindly extended and I have enjoyed myself very much this evening in meeting several of your members, and listening to the discussion on different types of mechanical and electrical apparatus.

So far as Air Filters are concerned, I happen to be connected with the firm who first manufactured this kind of equipment. I only want to say at this time that the baffle impingment type of air filter has proven very satisfactory, and acceptable in the electrical field, and the more modern type of apparatus, the mechanical automatic self cleaning air filter is very much preferred to the older type manually cleaning filter, where a man had to dip the cells in water and soda, and after cleaning in this way, and being left to drain a few hours, the cells were then dipped in Viscosine, an oily charging fluid, left to drain over night and then placed in their frames. The present type of filter regardless of who makes it, is more efficient and satisfactory on account of its automatic feature, and because it removes the human element in the cleaning operation.

The principle use for air filters is in the ventilation field aside from electrical or industrial application. Air Filters are widely used in Theaters, Hotels, Clubs, Apartment Houses, Department Stores, etc., where the ventilating air should be purified of dust, in order to protect health, upholstery, expensive hangings, paintings, decorations, and prevent the spoiling of merchandise or contamination of food products. In Department Stores dirty air causes damaged goods which have to be sold at sacrifice.

In the latter fields, the class of help is different, probably not as efficient as in the Industrial field when operations such as cleaning filters has to be considered. Also the Superintendance or Supervision are likely to be better in the Industrial Field, so that very frequently there has been a neglect in the cleaning of the manually cleaning filter. Dust would pile up on the filter cells, increasing resistance to the air flow, and causing expensive operation. In the automatic machine, we are able to arrange filter media differently on account of the automatic cleaning, and there is even a greater efficiency at less operating resistance. The cells have greater capacity than in the manually cleaning filters, and the automatic machines have proven much more acceptable in all fields as well as the Electrical.

George J. Walz: Mr. Pryibil, here is an air cleaning problem which we have had with us for many years at Steelton. In a steel foundry, where the crane operator has to shake out the moulds, the

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†Elec. Supt., Lehigh Div., Bethlehem Steel Co., Bethlehem, Pa.

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dry, gritty dust comes up to him in clouds, just as thick as you can possibly imagine. We have an awful time keeping men on those jobs; in fact we have had four or five in the last three or four years who contracted consumption, from that deadly dust. Would you consider it feasible, to close up the operators cage, putting in a glass windshield, with an automatic wiper and putting in air filters through which to feed clean air into him, or would that dust clog up those filters so fast that the scheme would not be practical.

P. L. Pryibil: You mean putting glass plates in front of the filter?

G. J. Walz: No. Put the glass windshield in front of the operator so that he can see to run the crane. At some other point you would have to put something that would let some clean air in. Could you fix up some entrance to that cage with your air filters that would keep out that cutting dust and let pure air in to that man.

P. L. Pryibil: Certainly, with the automatic cleaning filter. With the manual you would have to have a man stand there cleaning all the time; with the automatic it would clean itself.

G. J. Walz: There are some parts of that crane cage where these big clouds of dust do not strike directly, yet there are others where the dirt is extremely thick in the atmosphere all around. On a stationary cage you can put a blower in and run a pipe line out to where there is some pure air but on a moving crane, of course, this is out of the question.

P. L. Pryibil: No, not where the travel is long, except you have a complete ventilating system on the crane with filters attached to it or on the crane cage.

G. J. Walz: We would then carry a very slight air pressure on the inside of the operators cage. You feel that such an application could be worked out?

P. L. Pryibil: Yes, that could be worked out. Similar cases have been worked out in cement mills where the dust content is extremely heavy.

G. J. Walz: That would be a very similar condition, I believe.

P. L. Pryibil: Yes, it probably is.

A Member: In regard to the filter Mr. Burr spoke about, I would like to know whether it was provided to clean it when the power was off. Now that particular filter works on the principle it has a trip somewhere or a connection. When the fan stops that automatically starts the filter. Is the filter being cleaned while the fan stops? There are other types which have that baffle on so that the fan can be started on the mechanism actuated, so that the filter can be cleaned.

D. M. Petty: It has to be under operation to clean it?

P. L. Pryibil: No, there are automatic filters now that clean while the air is passing through. It would also be dangerous to work in a ventilating system for air where merchandise could be spoiled, or food products, where they have to be very careful.

A Member: On the Phoenix rotating filter it would seem that the air as it leaves the filter should be leaving the clean side of the filter.

W. H. Burr: From the information which I have been able to gather it seems that once the dust particles have imbedded themselves in this oil film they remain there until submerged in this viscous oil bath.

P. L. Pryibil: As to the efficiency of the dried air or baffle impingment filter, when it was brought out about ten years a go, it was, of course, necessary to Architects and consulting Engineers, that high cleaning efficiency could be combined with low resistance. There were different methods of testing, but, 97 to 99% efficiency in removing dust dirt and bacteria has been proven by test many times.

We have many installations of air filters in connection with the ventilating system on Hospitals, and recently it is considered good practice to provide for air filtration, especially for the operating rooms. In most cases, bacteria rides in on the dust particles, and if you keep the dust out, you keep most of the bacteria out. You can prove efficiency of air filtration by counting the dust particles in a field under the microscope. A simple unscientific method of proving that baffle impingment filter is efficient, is to put a celluloid sheet smeared with white vaseline behind the air filter, and then throw shovels full of dust and dirt on the front of the filter. This celluloid test sheet is depressed in the center and has a small orifice to assure suction. It might be left behind the filters for a short time or several days, but, you cannot see any dust on it.

A comparatively new field for air filtration is in connection with the Blowers on Organs in Schools, Churches and Moving Picture Theaters. It has been found very necessary to equip these Blowers with filters. Without filters they attempt to remove dust after it has gotten into the pipes with vacuum cleaners. A very considerable amount of dust is sucked into an organ when the blower is going at full velocity. Even the vaseline coated sheet will prove that not more than 3% of dust in the air stream can go through the air filter, and that you are cleaning 97% of the dust out of it.

D. M. Petty: If you could run an electric apparatus one year without a cleaner, it would mean you could run it three hundred times longer with a cleaner.

P. L. Pryibil: Of course with electrical apparatus, it is ideal to have refrigeration as well as cleaning. To cool an Auditorium where they want to have cool air in the summer, they use air washers for the cooling and humidification, but, they clean the air with baffle impingment filters in front of the air washers. In winter, cooling being unnecessary, the filters only are used. So far as scientific tests are concerned in connection with air washers, I think it is generally conceded that they do not take out carbon dust.

D. M. Petty: Water will not take out smoke.

P. L. Pryibil: No, neither will dry air filter. Fumes will go through.

Centrifugal Pumps With Automatic Equipment*

By N. C. BYE†

REMOTE control of centrifugal pumps with automatic priming features has been used fairly extensively in the mining fields for drainage purposes. These installations require many safety features to insure continuity of service and most of these features have been included in a unit we have recently installed for our factory water system.

Fig. 1 shows the general layout of the installation. The pump is located in the power house and pumps through a 20″ suction line 100′ long under suction heads of 6′ to 16′. It discharges directly into the service mains to which is connected a water tower. As the level rises and falls in the tower, the pump is automatically stopped and started to hold the level within predetermined limits. Insurance regulations required that the fluctuations of water level in this water tower do not exceed 8′ from the upper limit. With the new installation when the

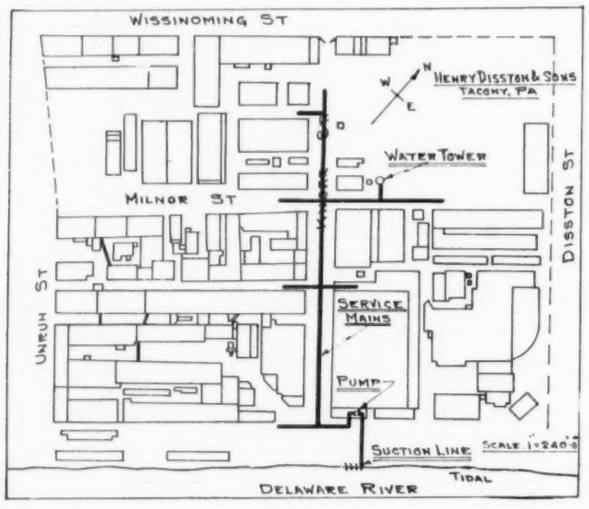

FIG. 1

pump is shut down the standpipe is supplying the flow and the 8′ is soon exhausted. As the pump requires priming before each start, the control operation must be both quick and sure.

Fig. 2 shows the automatic pump layout which comprises:

1—The main pump.
2—The main pump motor.
3—The dry air priming pump.
4—Priming pump motor.
5—Main pressure regulator.
6—Vacuum Breaker.
7—Starter for main pump motor.
8—Starter for priming pump motor.
9—Discharge time check valve.
10—Vacuum regulator in suction line.
11—Pressure regulator in pump discharge.

The method of operation is as follows: As the level in the water tower falls, the main pressure regulator makes contact starting the priming pump which exhausts the air from the main pump through the priming line and vacuum breaker. As the air is exhausted, water rises filling the main pump casing and up into the vacuum breaker. The water here raises a float closing the vacuum breaker switch starting the main pump motor and shutting down the priming pump motor. As the main pump motor

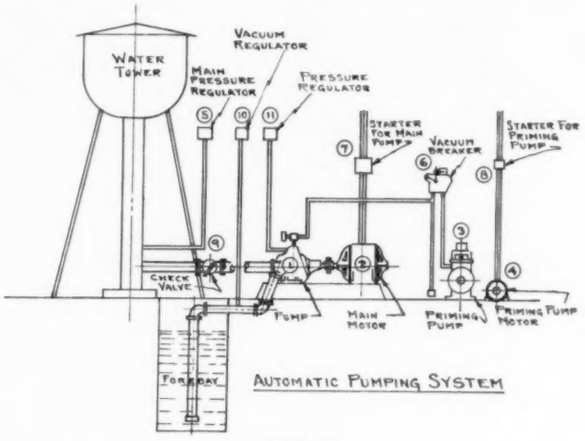

FIG. 2

increases in speed, it develops sufficient pressure to close an unbalanced spring loaded valve in the priming line shutting off the vacuum breaker and as the pump comes up to full speed, the pressure opens the main line check valve. The pump continues to run until the water tower is filled when the main pressure regulator is opened shutting down the pump, the main line check valve closing as the main pump loses speed.

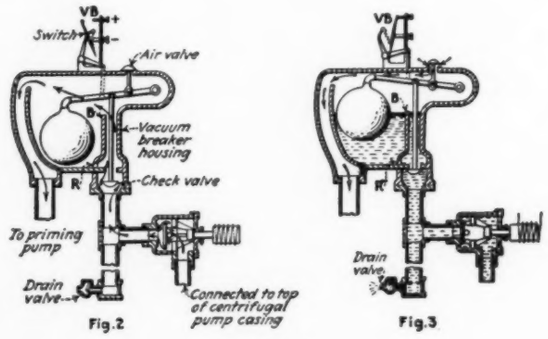

FIG. 3

The safety features are:

1—The vacuum regulator which opens in case of excessive suction as from a clogged intake.

2—The pressure regulator which opens in case discharge pressure fails as from broken discharge line, or if the pump becomes air bound and prevents completing the starting cycle unless the discharge pressure has built up to proper working limits.

3—The vacuum breaker which prevents starting of the main pump until it has been filled with water and also aids in shutting the main pump down if

*Presented before Philadelphia Section, A. I. & S. E. E., April 7, 1928.

†Mechanical Engineer, Henry Disston & Sons, Philadelphia, Pa.

pressure has not built up to a desired point within a certain time after starting.

4—A definite time relay which is set to allow the pump to repeat the starting cycle three times without completion before locking out the unit and giving an alarm.

Fig. 3 shows the vacuum breaker first as ready for priming. The spring loaded valve over the pump is open, the float is down opening the float check valve and closing the air valve and the drain check valve is closed. Air is drawn as shown, the water rising into the float chamber over the baffle until a lifting force is developed sufficient to break the seal on the air valve. The float rises quickly, closing the switch and shutting down the priming pump and starting the main pump. The rising of the float closes the float check which prevents water from the main pump being forced into the vacuum breaker until the pump pressure closes an unbalanced valve over the pump. As the air valve was opened by the raising of the float, the water in the vacuum breaker drains out through the drain check valve. This draining is slowed down by means of port "R" to enable main pump to build up pressure to close pressure regulator and shunt out the vacuum breaker switch before it opens.

Fig. 4 shows an elementary wiring diagram. The closing of the main pressure regulator closes a mechanical interlock, establishing a circuit through the definite time relay, the priming pump, starter coil and the normally closed contacts of relay 1CR. The closing of the priming pump starter relay

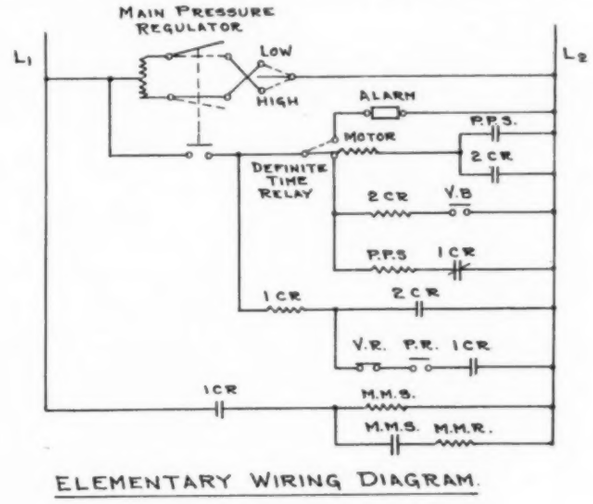

FIG. 4

starts the motor of the definite time relay and unless all subsequent operations are carried out within a given time, this will make contact with the alarm circuit giving warning.

The priming pump operates until the vacuum breaker switch closes which establishes a circuit through coil of relay 2CR, shunting out the priming pump starter relay for the time limit motor. The closing of 2CR relay also completes the closing circuit of 1CR relay which closes. The normally closed contacts open, shutting down the priming pump and the open contacts close, starting the main pump motor. As pressure builds up, the pressure relay closes shunting out 2CR which opens when the vacuum breaker drains empty. The opening of 2CR opens the circuit of definite time relay which drops back to starting point if the cycle has been normal. The running circuit is now complete through 1CR Relay, the pressure regulator and the vacuum regulator. The pump continues to run until the main pressure regulator opens circuit through holding coil of 1CR. In addition to these controls, there are bearing thermal relays, under voltage protection, and overload protection.

Fig. 5 is a pressure chart taken near the pump and shows why the pressure regulator had to be

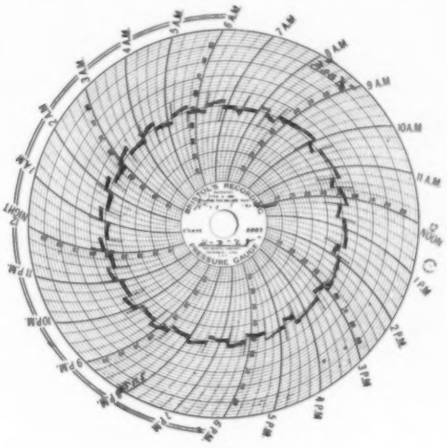

FIG. 5

located at the water tower. Most of the load is between the stand-pipe and the pump, and with the pump operating, the pressure at the pump is the stand-pipe pressure plus friction. With the pump idle, the pump pressure is stand-pipe pressure less friction. This causes the step in the chart and the height of the step varies with the plant load, so close control of the water level in the water tower required the location of the pressure regulator there.

DISCUSSION

George J. Walz*: I would like to ask Mr. Bye whether by installing this self-priming mechanism and these other protective thermo relays on the bearings, etc., whether they were able to do away with any labor at that pumping station?

N. C. Bye†: We did. When we started this, two men were laid off on 12-hour shifts.

G. J. Walz: That sounds as though the engineering that was applied to that installation was well worth while.

D. M. Petty‡: Do you make this power?

N. C. Bye: Part of it.

D. M. Petty: I think that is applying the principle which I have just recently discovered. I think this is a case where the various duplication of relays, etc., is the proper investment. You should have a duplicate pumping system to prevent a total loss of water. Water is one thing you can not get along without, so you don't want to put in a single unit pumping plant.

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‡Elec. Supt., Lehigh Plant, Bethlehem Steel Co., Bethlehem, Pa.

A Recuperator Unit For Industrial Furnaces Burning Oil*

By A. E. WALDEN†

WHEN I received the Season's Program, including that of this evening, much to my surprise I found that I was down for a paper and was supposed to have it ready on April 7.

This recuperator first came to my mind when using another type of cast iron recuperator on furnaces in the Baltimore and Ohio Shops at Baltimore, experimenting on some large furnaces heating 12" and 13" locomotive axles but until a year ago figures on the unit were not obtainable from the manufacturers.

Metallic heaters or recuperators for pre-heating the air to industrial furnaces using the heat in the waste or off gases for the purpose, have been more or less in general use for years, but the proper construction and shape of the metal structure has not been so well understood.

It is pretty universally agreed that recuperators increase the furnace efficiency and, therefore, only a brief description of the heater will be given here.

From the figure it will be noted that the unit was designed to be placed in the off gas flues as shown, but can be easily adapted to any furnace of reasonable size. The unit under consideration is a section of a Foster Superheater which has served so successfully as a steam superheater in connection with boilers of most every type and has many advantages.

The superheater section, as is well known, consists of a steel tube over which cast iron rings or fins are placed to collect the heat and to permit expansion in every direction, and afterwards the tubes are rolled into steel or cast iron flanges at one end and into a U tube at the other, which permits of easy installation or replacement and requires very little change in its re-design for use as a recuperator.

The heater unit, it will be noted, is built up of cast iron rings or fins on a steel tube as before stated, two of which are fastened into a U bend and the iron rings or fins fit over the tubes, allowing for expansion at "X". The unit can be constructed

*Presented before Philadelphia Section, A. I. & S. E. E., April 7, 1928.

†Wehr & Walden, Engrs., Baltimore, Md.

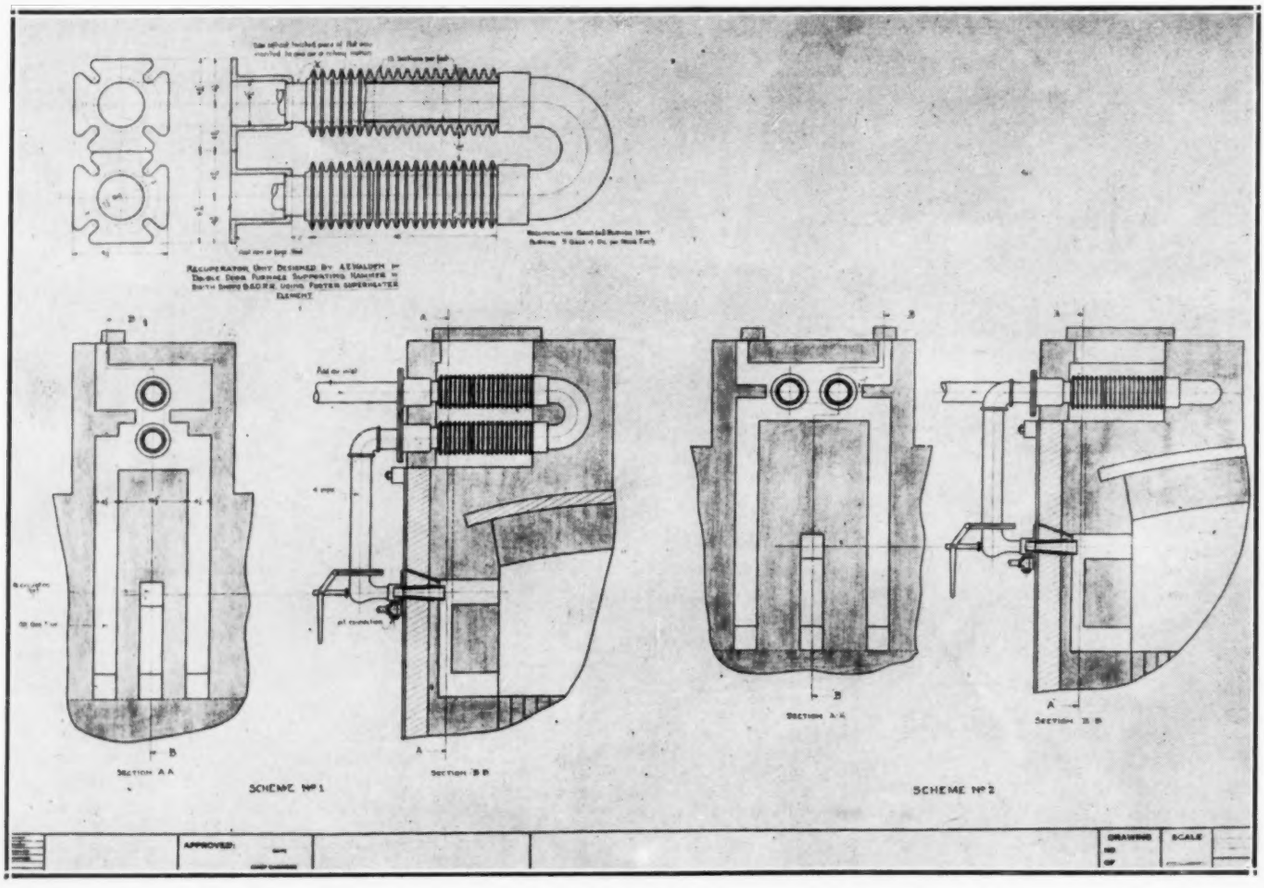


FIG. 1

in two sizes: 2" and 4" and may have a flat twisted strip inside the tube to give the air a rotating motion, or an inner tube with ends closed to thin out the air stream and increase its velocity between the inner and outer tubes.

Steam superheaters have a heat transfer of from about 6 to 13 B.T.U. per sq. ft. and those for heating air probably from 2 to 6 B.T.U., varying with the cleanliness and the air velocity.

The 2" unit has cast iron rings or fins of 3½" O.D. and 2 sq. ft. of area per foot of length. The 4" unit has rings or fins of 6⅝" O.D. and 6 sq. ft. of area per foot of length, and 13 sections per foot. The length of the tube can be varied to increase the heating area and its shape permits expansion to take place at all points. The fins increase the area exposed to the heat and concentrate it on the tube.

The limits of preheating probably should not exceed 1000 to 1200° for such a metallic heater unit, but superheaters have been in use in boiler settings for years with very high temperatures and at times no circulation, without appreciable damage or excessive repairs. The greatest damage will take place when the air is shut off and there is no circulation. For best results it is my opinion the blast pressure should be at least 16-oz. The air temperature from the recuperator will run from 500 to 700°F. depending on the furnace temperature.

I trust that this brief description may be of use to others and that they will be able to improve on its installation in other furnaces.

DISCUSSION

George J. Walz*: The device that Mr. Walden has described certainly looks to be worthwhile to any one who is in that field. Since you can buy this at an economical figure and it will increase the efficiency of such a furnace so much, it looks to me as though it should be on every furnace, but I do not happen to be any too familiar with either the oil or the gas fired furnaces, so I am going to call on some one, for further discussion of the subject, who is, Mr. Martin Conway, Combustion Engineer of the Lukens Steel Company, Coatesville, Pa.

Martin J. Conway*: There is little that I wish to add to Mr. Walden's paper. It is possible to save 15% and upward of the fuel cost on the forge furnaces Mr. Walden has described by the use of a recuperator. The question is which type of recuperator to install. I am not sure about the benefits to be obtained by the modified superheater sleeve on Mr. Walden's recuperator and think that as much surface is required on the inside as on the outside for the proper transfer of heat to the air to be heated.

It is unusual to use 16 ounces of air pressure on most low pressure oil or gas fired installations, yet Mr. Walden thinks this pressure is necessary for the most economical operation of his recuperator.

One feature about Mr. Walden's recuperator. as I see it, is the objection of the number of joints that would of necessity be in a large preheater installation which is a feature we usually try to eliminate.

Otherwise I see nothing about the recuperator that would prevent it from being practical and it no doubt works out allright on small installations where the temperature of the waste gases is not excessively high.

D. M. Petty†: At what temperature does that air come into the flames?

A. E. Walden: Usually around 500° to 700°. It can be carried higher, up to 1,000°, but then the piping gets pretty hot, and the other castings on that particular unit were made of cast steel.

George H. Schaeffer‡: Mr. Conway answered the question I had in mind, and that was in regard to the saving. Mr. Conway said the saving was about 15% of oil.

M. J. Conway: At least that.

G. H. Schaeffer: That is all I had in mind.

*Asst. Elec. Supt., Bethlehem Steel Co., Steelton, Pa.

†Elec. Supt., Bethlehem Steel Co., Bethlehem, Pa.
‡Elec. Engr., Carpenter Steel Co., Reading, Pa.
*Combustion Engineer, Lukens Steel Co., Coatesville, Pa.

Physical Conditions of a Steel Mill as a Factor in Safety

By H. W. DARR*

THE physical condition of any industrial plant has the same relation to modern methods employed in accident elimination as the life of George Washington, Abraham Lincoln, and other of our great ancestors have to present day modes and methods of carrying on in any line of work.

"Lives of great men all remind us;
We can make our lives sublime,
And, departing, leave behind us
Foot-prints on the sands of time."

All we now see and want to see of a successful strenuous campaign wholly along the line of physical safety, if we want to achieve success, are the "foot-prints on the sands of time" of physical safety as a major factor in reducing accidents.

Every worth-while movement has a beginning and usually this beginning is very crude and yet vitally necessary. The cave man depended on physical strength to accomplish his ends. He had a brain but used it very little. However, he used it up to the degree of his enlightenment co-incident with his age. The Egyptians built the pyramids by human strength and energy with but a little more of the mental ingenuity displayed by the cave man. We come down to the time of the great revolution which freed our nation from foreign tyranny and we note the crude methods of warfare. Physical strength and endurance were the great factors here and yet

*Asst. Supt., Safety Dept., Cambria Plant, Bethlehem Steel Co., Johnstown, Pa.

this was but a few short years ago. Coming to the period of the great war, the implements and human ingenuity displayed are incomparable with those of just a few years before. And so on, we might enumerate innumerable lines of development and in every instance you will note that as mental aptitude increases, physical conditions increase with it in efficiency, and all tending to decrease the responsibility of the human body and the elimination of physical energy. The same is true with this great world wide safety movement. At the time of its inception as an active life preservation movement the only thought was the elimination of dangerous places and conditions by means of physical safeguards or barricades. Instead of trying to educate the man to keep out of danger we spent all our time and material on the danger spot, protecting it so that the man could not get into it rather than trying to educate the man at the same time to protect himself. How foolish it all seems now, but true to nature, it was necessary.

This movement is so new and so far from perfection that we sometimes think it is impossible to note any particular outstanding line of progress, but in the few short years that the safety movement has lived a number of important lines of development have sprung up, lived their usefulness, and faded into oblivion. True, we must and will keep them in our memories as we do the lives of our great ancestors. They aid in spurring us on to greater things of a finer nature, nearer to the goal of perfection.

Let us take a few examples and go back just the short space of ten years. In a large steel plant with which I am very familiar, during the year 1917, 213 men were injured in the course of hand tool operations, sufficiently to keep them from work for two or more days. Ten years later, in 1927, in this same plant with practically the same working force only 18 men were injured in like manner. This is a reduction of 92%, or one-twelfth as many men injured. The question now arises, are the tools twelve times as good now as they were ten years ago? Do we have better workmen now and do they understand the use of tools twelve times better than they did ten years ago? All these questions can be answered with one emphatic NO. But they have learned one thing and acquired one positive trait. They have learned to say No to using a tool that is unfit for use or to a practice involving the use of tools unfit for service. This refusal to use inferior implements of labor has brought about a gradual improvement in the quality of tools used and at the same time has aroused a line of thought in the mind of the workman that has branched out into other surrounding conditions which has all been instrumental in bringing about better and safer physical working conditions. It is the original thought of the man who is paid to think, working through the workman in the mill that reflects better and safer physical conditions. It should never be said that the worker in the mill has had no part in making any plant safer. Safe working conditions will grasp our attention unconsciously and work through us in a visible manner if we are willing to adjust ourselves to surrounding conditions and become an integral part of the organization to which we belong.

Speaking of examples, which is the best method of illustrating any point, in this same steel plant during the year 1917, 138 railroad accidents were recorded, many of which were of a very serious nature, while the year 1927 netted but 12 lost time accidents along the same line of work and in the same division. This is practically the same ratio of reduction as noted in the hand-tool accidents. We may go a little farther with this class of accident and state that more of the same men are still in this line of work than is true of the hand-tool class. Practically the same locomotives, cars, tracks, and other equipment are being used as were used ten years ago. Why then this great reduction in accidents? Safe-guards? No. Impossible. Decreased operations? No. Any particular physical reason? No. The answer is simply this: Men have learned to evaluate life; to use their God-given faculty of perception and apprehension; to know that haste without reflection leads to destruction; to THINK. The day when the foreman was supposed to do all the thinking for his men is gone forever. The foreman is now a leader, not a driver. All men have learned to appreciate their position with any corporation and to feel their responsibility as a part of the organization.

May we repeat that physical safety has practically faded into oblivion and in its stead has loomed up the greater and nobler achievement, protecting the man through his mental capability rather than protecting a machine against its operator. This, however, is still required but less needed than it was ten years or more ago.

. John L. Barker, Elec. Engr., Sharon Steel Hoop Co., Sharon, Pa., met with a serious automobile accident at Salem, Ohio, that resulted in his death Thursday, June 28, 1928. Mr. Barker had been an active member of the A. I. & S. E. E.

for the past ten years and enjoyed a wide acquaintanceship in the Iron and Steel Industry in the United States. He was connected with the Sharon Steel Hoop Co. in the capacity of electrical engineer for the past ten years.

A. I. & S. E. E. JUNIOR DIVISION

(Devoted to practical problems of electrical department employees in the Iron and Steel Industry)

DIRECT CURRENT MAGNETIC CONTROLLERS

MAGNETIC Controllers are made in so many different varieties that it would be impossible to illustrate and describe all of them in any reasonable amount of space, therefore, in the following article, only a few controllers involving the later principles of design and in common usage will be discussed and illustrated.

Reversing Controller With Series Relay Acceleration

Fig. 1 shows a simple reversing controller with series accelerating relays. A complete wiring diagram of a similar controller is shown in Fig. 2. The principal elements making up the controller are shunt line, directional and accelerating contactors, series accelerating relays, overload relay, low voltage contactor, line and control switches and a suitable master switch. The master switch in this case is a two point master providing two points of speed control in either direction. The operation of the control is as follows:

Forward: When the master switch is placed in the forward position the operating coils of directional contactors 1 and 3 and line contactor 5 are energized causing them to close and establish the motor circuit through the starting resistor. In closing, contactor 3 depresses the cap of the accelerating relay tending to close the relay contacts. These contacts, however, are held open magnetically by the heavy line current flowing through the series operating coil. When the current drops, due to the motor gaining speed, to the value for which the relay is set the contacts will close, completing the circuit of the operating coil of contactor 11, causing it to close and short out section R_1 to R_2 of the starting resistor. Contactor 11 in closing depresses the cap of its accelerating relay which functions the same as explained above and completes the circuit of the operating coil of contactor 12, causing it to close and short out section R_2 to R_3 of the starting resistor. The same operation is repeated until all accelerating contactors have closed and shorted out the entire starting resistor.

Overload Protection: In case of an overload due to grounds, shorts or other trouble, the contacts of the overload relay (OL) open, breaking the control circuit, thereby allowing all contactors to drop open. The same thing will happen in case of a voltage failure through the medium of the low voltage contactor (LV) whose contacts open the control circuit. The contacts of the low voltage contactor are in series with its own operating coil so that it does not close of its own accord after opening from voltage failure or tripping of the overload relay. A reset segment, which by-passes the contacts of the low voltage contactor, is provided in the off position of the master switch, making it necessary to return the master switch to the off position to reset the low voltage contactor.

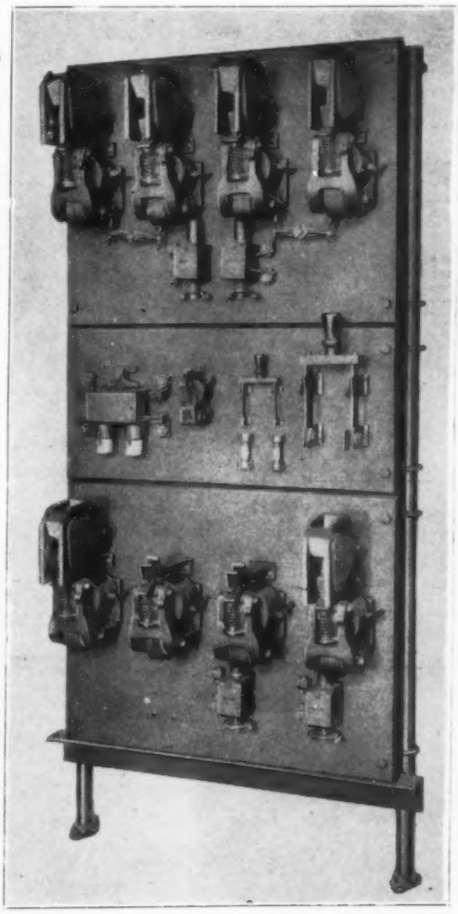


FIG. 1

Reversing Controller With Cutler-Hammer Inductive Time Limit Acceleration

Figs. 3 and 4 show a front and rear view of a Cutler-Hammer Inductive Time Limit Controller. Fig. 5 shows a complete wiring diagram for a similar controller. The principal elements making up the controller are shunt line and directional contactors, shunt accelerating contactors with shunt lockout coils, two overload relays for each side of the line, main line and control knife switches, transformer which provides timing of accelerating contactors and a suitable master switch. The master switch shown in this diagram is a multipoint master which gives the operator control of each step of acceleration. The operation of the controller is as follows:

Forward: When the master switch is thrown to the forward position contactors M. 1F and 2F close immediately, completing the motor circuit through the starting resistor, taps of which are connected at R_1, R_2, R_3, R_4 and R_5. When 1F and M close, interlock contacts operated by them close, completing the circuit for the closing coils of the accelerating contactors 2R to 5R, however, they are held open by their respective lockout coils which are energized by transient currents set up by the transformer coils TC-1 to TC-5. TC-1 is connected across the armature and controls the plugging

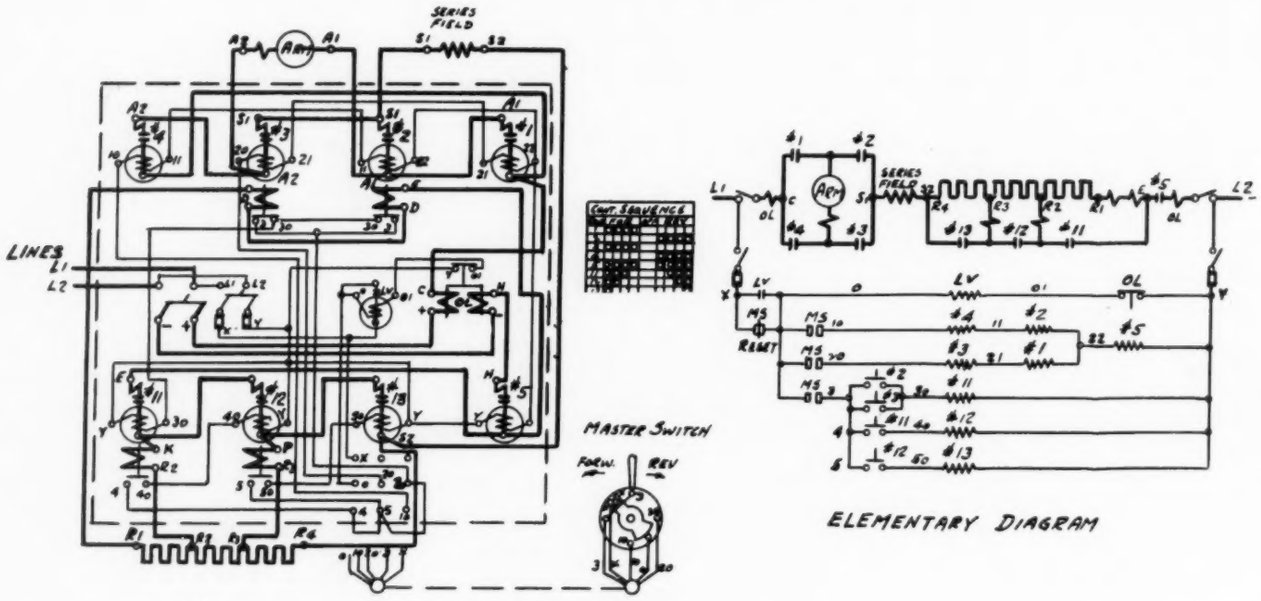


FIG. 2

operation. TC-2 is short circuited by the lockout coil of the first accelerating contactor 2R. TC-3, TC-4 and TC-5 are connected across steps of the starting resistor and in series with the lockout coils of contactors 3R, 4R and 5R respectively. TC-3 and TC-5 are connected cumulative and TC-4 is reversed to give a bucking effect. With the initial inrush of current to the motor TC-1, TC-3, TC-4 and TC-5 are excited by the voltage drop in the armature and sections of the starting resistance respectively. Since the drop in the armature is very low the effect of TC-1 is practically negligible. Due to the flux set up in the transformer core by TC-3 and TC-5 overcoming the bucking effect of TC-4 a current is set up in TC-2, which holds out the first accelerating contactor 2R. The holding out period depends upon the design of the transformer and lockout coil and the adjustment of the air gap on the contactor. When 2R closes TC-3 is short circuited causing a change in flux in the transformer core. This change in flux sets up a transient current in TC-3 which controls the holding out period of

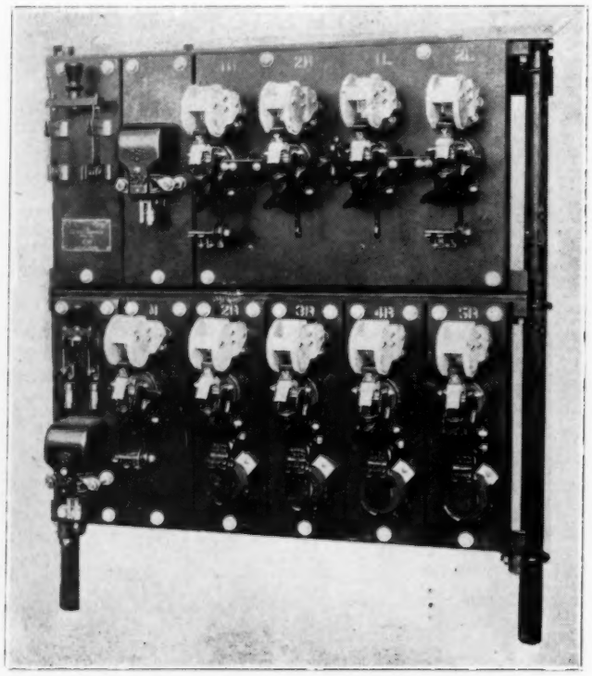


FIG. 3

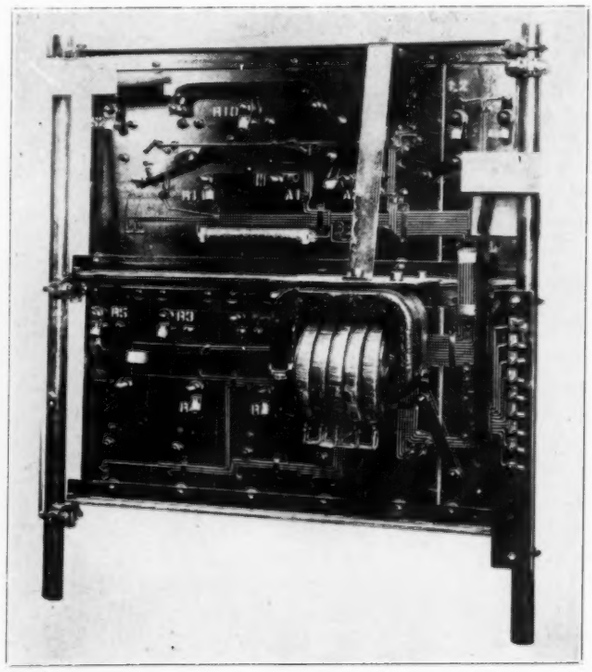


FIG. 4

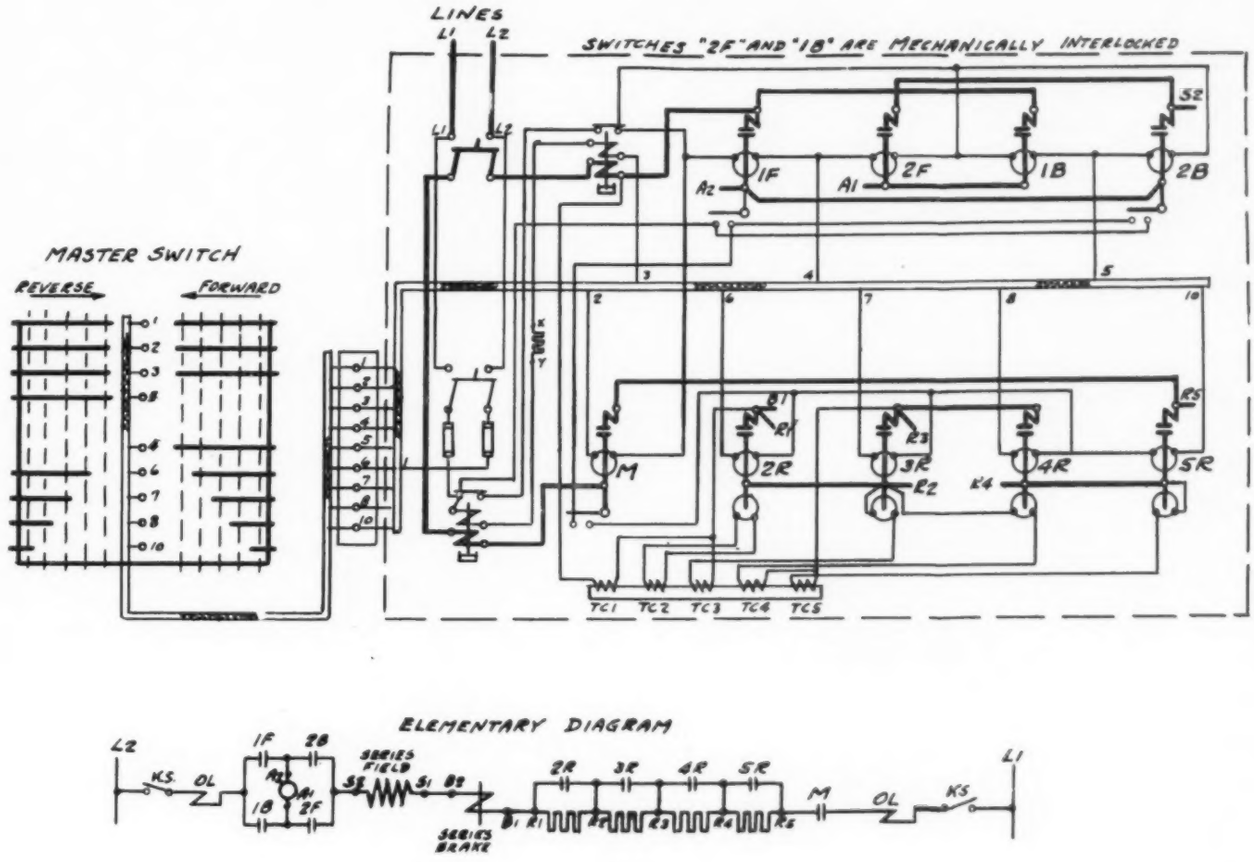


FIG. 5

contactor 3R in the same manner as for the first accelerating contactor 2R. When 3R closes TC-4 is short circuited and the same action takes place as before. This continues until all accelerators have closed and the motor is across the line.

Reverse: When the master switch is thrown to the reverse position the operation is the same except that contactors 1B and 2B close instead of 1F and 2F.

Plugging: When the motor is plugged the first accelerating, or plugging contactor, is held open until the motor comes to rest and starts in the reverse direction through the action of transformer coil TC-1. TC-1, being energized by the counter voltage of the motor, sets up a heavy flux in the transformer core which in turn sets up a current in TC-2, thereby holding contactor 2R open. After the motor comes to rest and starts in the reverse direction the acceleration goes on the same as when starting from rest.

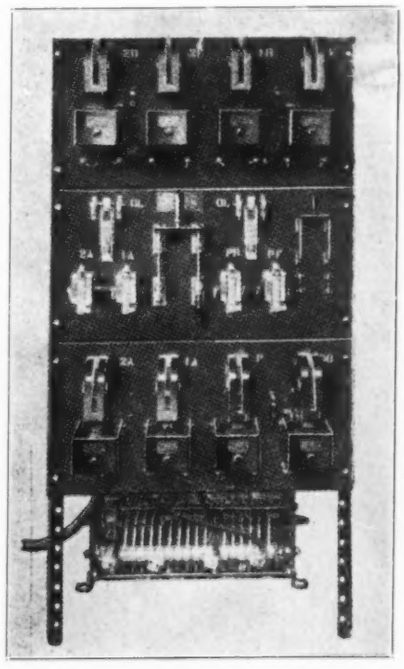


FIG. 6

Overload Protection: In case of overloads the overload relays open, thereby breaking the control circuit and allowing all the contactors to drop open. The small shunt coil in the overload relays are holding coils to keep them open after they have once tripped. When the master switch is returned to the off position the circuit for the shunt holding coils is broken and the overload relays reset by gravity.

Reversing Controller With G. E. Co. Definite Time Accelerating Relays

Fig. 6 shows a simple reversing controller with G. E. Co. definite time accelerating relays. Fig. 7 shows a complete wiring diagram for a similar controller except that it has three steps of acceleration instead of two. The principle elements making up this controller are shunt directional and accelerating contactors, a shunt circuit breaker contactor, forward and reverse plugging relays, accelerating

relays for each accelerating contactor, overload relays for each side of the line and a suitable master switch. The master switch shown in this case is a forward and reverse master with three steps of control in each direction. The operation of this control is as follows:

Forward: When the master switch is thrown to the forward position directional contactors 1F and 2F close completing the motor circuit through the starting and plugging resistor R_1 to R_5 and circuit breaker contactor CB, which is closed at all times. The voltage drop across the various sections of the starting and plugging resistor, due to the starting current, energizes the coils of relays PF, 1A, 2A and 3A causing all of them to pick up. Relay PF which is normally open closes and completes the circuit for the operating coil of contactor P causing it to close and short out the plugging resistor R_1 to R_2. Relays 1A, 2A and 3A which are normally closed open the circuits of their corresponding contactors 1A, 2A and 3A preventing them from all closing immediately. When contactor P closes it short circuits the coil of relay 1A allowing it to close and complete the circuit for the operating coil of contactor 1A. However, relay 1A does not close immediately as it is so designed that a definite time is required for the flux set up by its coil to die out and release the contact arm. When contactor 1A closes short circuiting section R_2 to R_3 of the starting resistor it also short circuits the coil of relay 2A. After a definite time the flux in relay 2A dies out and its contacts close completing the circuit for the operating coil of contactor 2A. This process continues until all accelerating contactors have closed and the motor is across the line.

Reverse: When the master controller is thrown to the reverse position the same operation takes place except that contactors 1R and 2R and relay PR close instead of contactors 1F and 2F and relay PF.

Plugging: If the motor is plugged relays PR or PF will not close immediately as the counter voltage of the motor will oppose the voltage drop across the first step of resistance and the resultant voltage impressed on the relay coils will be negligible. As the motor speed approaches zero the voltage drop in the resistor predominates and closes the plugging relay and the operations proceed the same as in starting from rest.

Overload Protection: In case an injurious overload due to grounds, shorts or other causes comes on, the overload relays OL open up breaking the control circuit through the operating coil of the circuit breaker contactor CB. The overload relays close immediately as soon as CB opens, but in order to start again the master switch must be returned to the off position to reset or close CB. An auxiliary contact on the operating arm of CB opens its own circuit and must be by-passed by the reset segment in the off position of the master to close again.

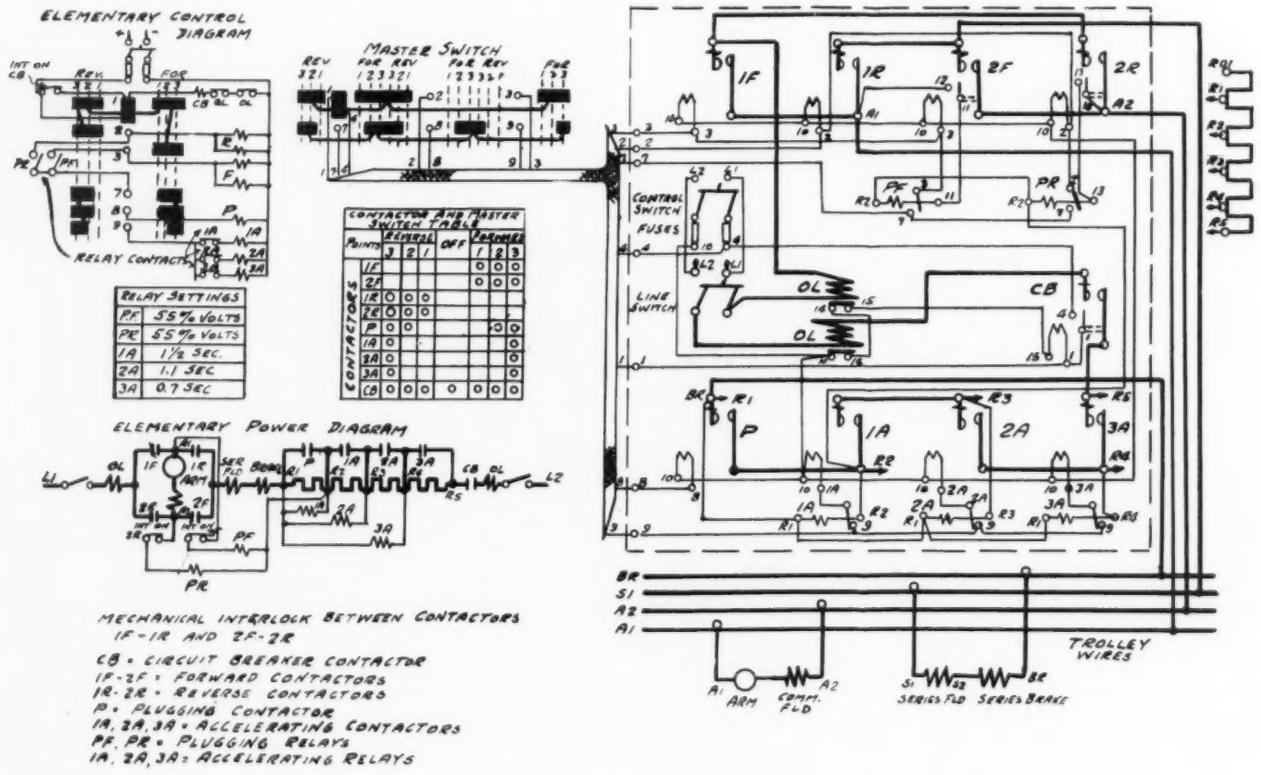


FIG. 7

Items of Interest

The Ohio Electric & Controller Company wishes to announce the appointment of the following representatives:

Charles L. Ward Company, 701 Midland Building, Kansas City, Mo., covering the territory of Kansas City and the territory surrounding it, Omaha, Nebraska and Dallas, Texas and the territory adjacent thereto.

J. Dale Reynolds, Apartado 428, Monterey, N. L., Mexico, covering the country of Mexico.

The Rollway Bearing Company, Inc., Syracuse, N. Y., announces the appointment of Alfred E. Munch, Jr., as representative in the Chicago-Milwaukee District, with headquarters at 544 Railway Exchange Building, Chicago.

Due to the semi-arid climate of Spokane, demands upon the city water works reach a maximum of over 550 gallons per capita per day in July. There is, however, an apparently unlimited source available in artesian wells, which, with cheap power from hydro-electric plants and large, efficient, modern pumps, makes it possible to supply water having a temperature of about 48° F. and absolutely free from bacterial life, at a comparatively low cost per thousand gallons. The new Spokane Up-river Pumping Station is described in a leaflet now being distributed by the De Laval Steam Turbine Co. of Trenton, N. J., which supplied the pumping equipment.

The Harold E. Trent Company of Philadelphia, Pa., announces a new pot type electric heating furnace suitable for lead, salts and cyanide. The most notable characteristic is the relatively small diameter or space occupied by the furnace without any increase in temperature on the outside of the furnace casing. Another physical feature of the construction is that the cover lifts away from the pot in two halves by means of counter balanced weights and there is therefore no interference between the cover and the thermo couple and the working surface of the furnace available.

More information in connection with this furnace will appear in a later issue of the Iron and Steel Engineer.

The Ideal Commutator Dresser Company, Sycamore, Ill., have added a new product to their line known as the Ideal Mica Undercutter, (motor driven). The first showing of this Undercutter at a recent Exposition excited considerable favorable comment. The Ideal Undercutter is a complete departure from the ordinary practice, because it is so constructed that it is not necessary to remove a single brush when undercutting a commutator.

Literature in connection with this undercutter may be had by addressing the Ideal Commutator Dresser Company at Sycamore, Ill.

The Pyle-National Company, Chicago, have opened three offices. One in Pittsburgh, Pa., located at Room 2241 Oliver Building, Thomas P. McGinnis in charge. Another office at Boston, Mass., Room 716-718 Little Building, Carl S. Geis in charge. The third office is at Houston, Tex., Room 1000, Marine Bank Building, Alex. E. Johnson in charge.

Mr. J. S. Murray has just recently been appointed Electrical Engineer of all the Follansbee Brothers Plants. Mr. Murray has been an active member of the A. I. S. E. E., for the past ten years and has contributed to the columns of the Iron & Steel Engineer many valuable articles, among them being "Electrification of Sheet Mills," which was one of the most comprehensive articles covering this subject, that ever appeared in the Society's Transactions.

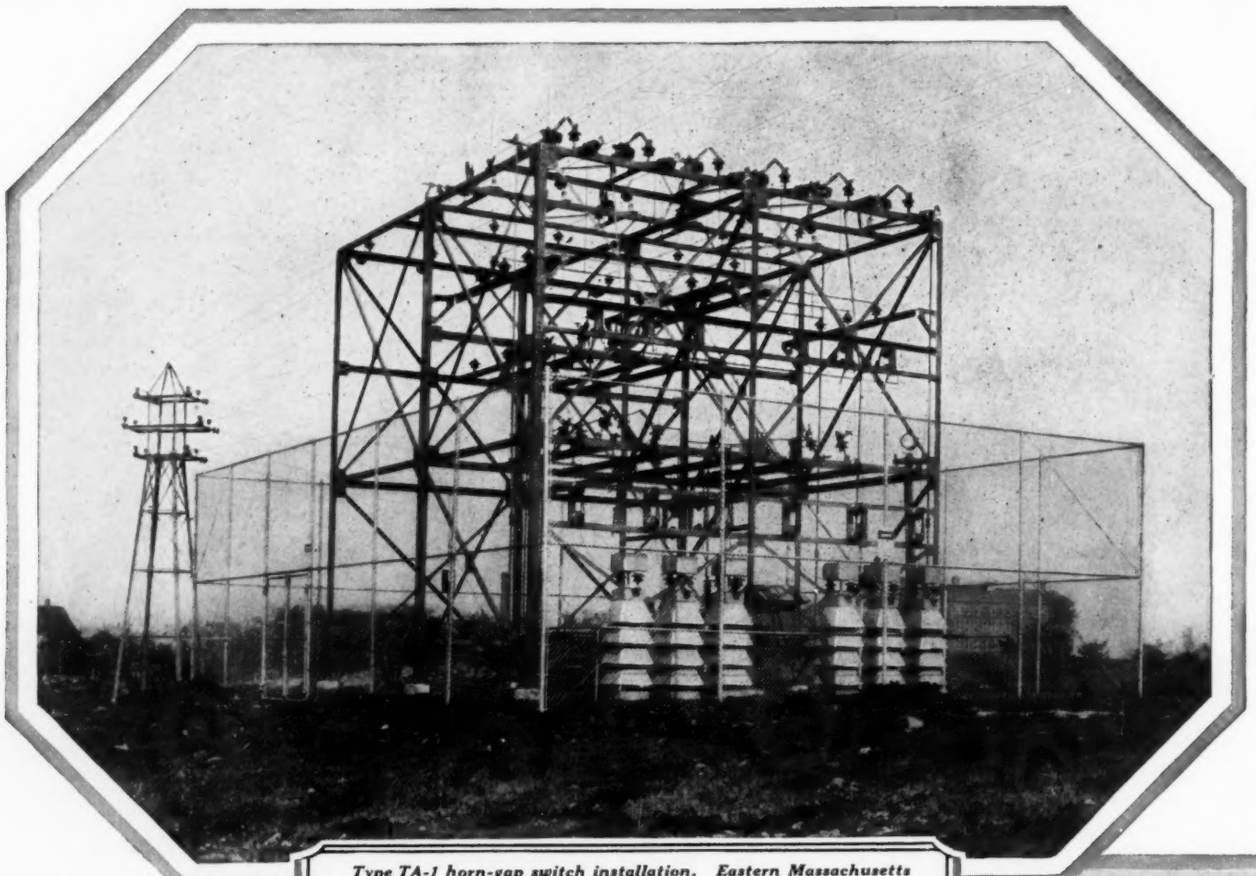
J. S. MURRAY

William T. Holmes, vice president of the Monitor Controller Company, of Baltimore, Md., died at his residence in that city Saturday, June 9.

Mr. Holmes was born in Philadelphia, 51 years ago, and has been associated with the Monitor Controller Company interests for about 25 years. For the last ten years he has been vice president of the company.

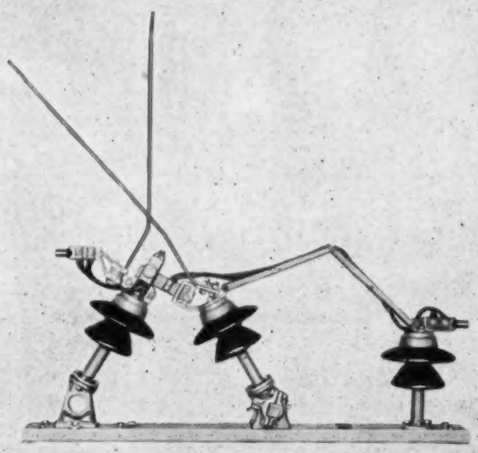
Mr. Holmes was one of the greatest control engineers in the country. He participated especially in the development and application of current limit control and time limit control systems, which were originated by the Monitor Controller Company. His mind was particularly apt and keen in the analysis of control problems in the field—in shops and plants where electric motor control had to be applied in particular ways to accomplish specific results.

Gears and Forgings, Inc., Cleveland, O., manufacturers of Gears, Forgings, Speed Reducers and Special Machinery has appointed Potter & Dugan, Incorporated, Erie County Bank Building, Buffalo, N. Y., as district sales representatives for Buffalo and vicinity.



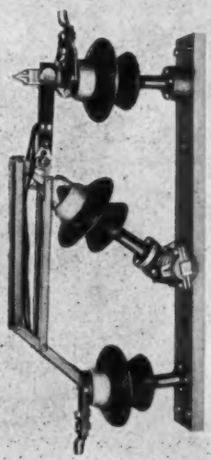
Type TA-1 horn-gap switch installation. Eastern Massachusetts Electric Co., Salem, Mass.

TYPE TA-1



Single-pole element of horn-gap switch for horizontal mounting

TYPE TA-2



Single-pole element of isolating switch for vertical mounting

Your purchase of G-E outdoor station equipment is assurance of a permanent source of renewal parts and the services of a nation-wide organization of specialists. For complete information on Type TA switches, ask the nearest G-E office for a copy of GEA-460B.

GENERAL

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK